Radio, Electronics and Communications

FORMERLY "RADIO & ELECTRICAL REVIEW" — WIDELY KNOWN SINCE 1946 AS "R. & E."

MPL

In This Issue . . .

- Development and research on V.L.F. propagation.
- Medium and High Frequency band aerial with vertical directivity.
- C.C.I.R. interim study group meetings.
- The British Post Office tower.
- Thin Film memories.
- Mobile Communications.
- Listening Post, Book Reviews, Serviceman's Column.

NOVEMBER 1, 1965

PUBLISHED MONTHLY IN THE INTERESTS OF THE N.Z. ELECTRONICS INDUSTRY FOR ALL LEVELS, FROM PROFESSIONAL TO AMATEUR.

VOLUME 20 NUMBER 9

PRICE 2/6

AWA

DELIVERS DUNEDIN

OUTSIDE BROADCAST VAN

ENQUIRY CARD AD. 1

The pearl in the bivalve, the valve in electronics—each is the essential element, precious in its context. But no deep-sea diving is needed to make sure of the valve: for true reproduction and consistent reliability.

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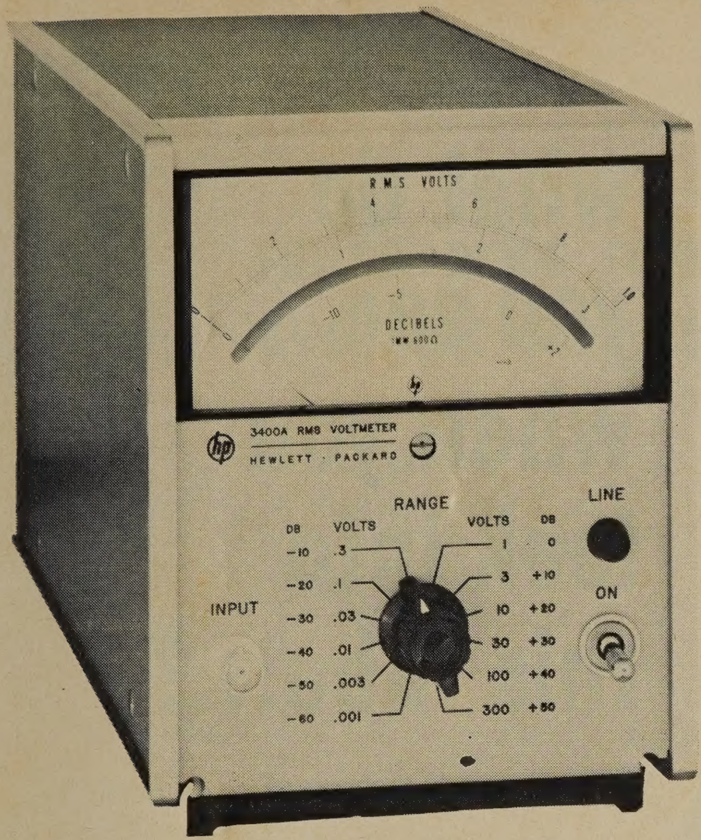

NEW ACCURACY

a true rms voltmeter with this unprecedented combination of features :

• rugged taut-band meter • unequalled crest factor for accurate measurement of noise and pulses • linear scale for unparalleled resolution, plus linear dc output • full scale accuracy within ±1%, 50 hz to 1 mhz; ±2%, 1 mhz to 2 mhz; ±3%, 2 to 3 mhz; ±5%, 10 to 50 hz and 3 to 10 mhz • measures 100 µv to 300 v, —72 to +52 db, 10 hz to 10 mhz • small, compact, easy to use.

New hp Model 3400A measures the actual root-mean-square value of ac voltage from 100 µv to 300v, 10 hz to 10 mhz. Precise rms measurements can be made of sinusoidal voltages or nonsinusoidal signals having crest factors (ratio of peak to rms) as high as 10 at full scale and as high as 100 at 10% of full scale deflection. Here is the ideal instrument for making accurate measurements of noise and pulse trains, without the need for correction factors.

The 3400A features 12 full-scale ranges, selectable by a front-panel switch which changes attenuation in accurate 10 db steps, permitting most readings on the upper two thirds of the scale for highest accuracy and making possible a convenient scale calibrated from —12 to +2 db for measuring db from —72 to +52.

Rugged taut-band meter assures longer life under tough environmental conditions, provides accurate tracking despite repeated overloads. Meter scale is linear for high resolution; each scale is custom calibrated to match its particular meter movement.

For even higher resolution, the 3400A furnishes a dc voltage proportional to the rms value of the input, useful for driving accessories such as X-Y and strip-chart recorders or to drive a digital voltmeter.

The compact 3400A is only 5⅛″ wide and 6½″ high and weighs a mere 7¼ lbs.

Call or write Sample Electronics field engineer today for further information on this remarkable true rms voltmeter.

SPECIFICATIONS

Range:	100 µv to 300 v rms 12 full scale ranges from 1 mv to 300 volts, 3, 10 sequence; —72 to + 52db
Meter Scales:	voltage, 0 to 1 and 0 to 3; decibel, —12 to +2 db
Frequency Range:	10 hz to 10 mhz
Accuracy:	within ± 1% of full scale. 50 hz to 1 mhz ± 2% of full scale, 1 mhz to 2mhz; ± 3% of full scale, 2 mhz to 3 mhz; ± 5% of full scale, 10 to 50 hz and from 3 to 10 mhz
Response:	responds to rms value (heating value) of the input signal for all waveforms
Crest Factor (ratio of peak amplitude to rms amplitude):	10 to 1 at full scale, inversely proportional to pointer deflecttion; e.g., 20 to 1 at half scale, 100 to 1 at tenth scale
Response Time:	typically < 2 sec to within 1% of final value for a step change
Overload Protection:	40 db or 425 v rms, whichever is less, on each range
Maximum Input:	425 v rms
Input Impedance:	10 megohms shunted by 25 pf
Output:	negative 1 v dc at full scale deflection, proportional to pointer deflection; 1 ma maximum; nominal source impedance is 1000 ohms
Power:	115 or 230 v ± 10%, 50 to 60 hz, approximately 7 watts
Dimensions:	5⅛″ wide, 6½″ high, 11″ deep
Weight:	net 7¼ lbs.
Accessory Furnished:	10110A Adapter, BNC to dual banana jack
Price:	3400A RMS Voltmeter, £275/10/-; $N.Z.551.00

Data subject to change without notice.

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ENQUIRY CARD AD. 3

what do you see when you look into this tube...?

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Look hard - really hard, for behind every Miniwatt trademarked tube stands a worldwide organisation of repute and renown. An efficient organisation with top-ranking scientists in metallurgy, chemistry, electronics, physics..., vast laboratories..., thousands and thousands of specially trained workers. experience of many years of manufacturing... and these are but a few aspects of what goes into producing tubes of top-quality...... Miniwatt tubes. What does this mean to you?

YOUR GAIN!

And not only your gain - but your customers' as well! For your customers rely upon you to do a good job when their sets need repair. And satisfied customers will come back and buy from you again and again. Miniwatt makes for satisfied customers. They know they can rely on you, you know you can rely on Miniwatt... always to have the right tube in stock... always a guaranteed top quality... and to render you the service only a leading manufacturer can - both now and in the future!

A WORLDWIDE ORGANISATION IS BACKING UP YOUR BUSINESS

PHILIPS

PHILIPS MINIWATT

ENQUIRY CARD AD. 4

SILICON DIODE POWER TRANSFORMERS AVAILABLE FROM BEACON RADIO LTD.

R98 T.V. POWER TRANSFORMER

For R.T.V. & H. 1959 and later T.V. Sets. Delivers 260v @ 300mA D.C. Full wave voltage doubler.
230:115v A.C. @ 300mA D.C.
:12.6v C.T. @ 5A (2 windings ea. 6.3 @ 5A).
:0—6.3—7.5—9 @ .6A. Picture tube winding.
Choke:—C36. Use 400v P.I.V. Diodes.

R103 Stereo Power Transformer

R.T.V. & H. Aug. 60. 7w Stereo.
230:245v @ 150mA. D.C.
:104v @ 150mA D.C. Voltage doubler Rect.
:6.3v C.T. @ 5A.
Choke:—C42. Use 400v P.I.V. Diodes.

R104 Stereo Power Transformer. 10w

320v @ 320mA. Voltage doubler Rect.
230:130v @ 320mA.
:6.3v @ 6A.
Choke:—C49. Use 500v P.I.V. Diodes.

R105 T.V. Power Transformer For Philips T.V. Kitsets

220v @ 420mA D.C. Voltage Doubler Rect.
230:106v @ 420mA D.C.
:6.3v @ 10A.
:0—6.3—7.5—9 Ov @ 0.3A. Picture tube Winding.
Choke:—C45. Use 400v P.I.V. Diodes.

R106 T.V. Power Transformer for Philips T.V. Kitsets

This type similar to R105 but less Picture Tube boost taps. Main Fils. 12.6v C.T. @ 5A.
220v @ 420mA D.C. Voltage Doubler Rect.
230:106v @ 420mA D.C.
:12.6v C.T. @ 5A (2 windings 6.30v @ 5A each).
:6.3v @ .3A Picture tube winding.
Choke:—C45. Use 400v P.I.V. Diodes.

R108 Small Stereo Headphone Power Transformer

250v @ 22mA D.C.
230:110v @ 22mA D.C. Voltage doubler Rect.
:6.3 @ 0.86A.
Choke:—C41. Use 400v P.I.V. Diodes.

R110 T.V. Power Transformer. For Philips T.V. Kitsets

This transformer uses full wave bridge rectifier. Requires no limiting resistor unlike equivalent voltage double types, also has advantage of no insulated capacitor and lower ripple output with smaller choke.
Output 220v @ 420mA D.C.
230:172v @ 420mA D.C. Full wave bridge Rect:
:12.6v C.T. @ 5A (2 only 6.3v winding @ 5A).
:6.3v @ .3A Picture tube winding.
Choke:—C50. Use 400v P.I.V. Diodes.

R111 T.V. Power Transformer

Similar to R110 but for R.C.A. type Kitsets.
260v @ 350mA from Rect.
230:207v @ 350mA D.C. Full wave bridge Rect.
:12.6v C.T. @ 5A (2 only 6.3v windings each 5A).
:6.3v @ 0.6A. Picture tube winding.
Choke:—C42. Use 400v P.I.V. Diodes.

R112 Oscilloscope Power Transformer

R.T.V. & H. 1963. Calibrated.
230:110v @ 80mA D.C. Full wave voltage doubler.
:6.3v @ 2.4A.
:6.3v @ 1A.
:6.3v @ 1A.
Use 400v P.I.V. Diodes.

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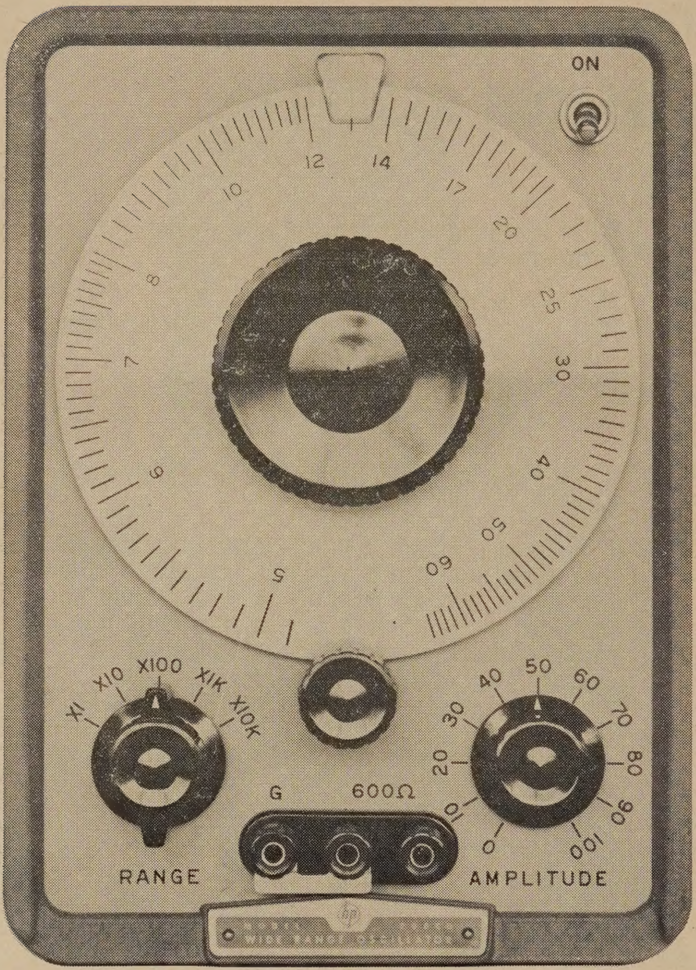
ENQUIRY CARD AD. 5

NEW SPECIFICATION FOR AN OLD FAITHFUL H-P MODEL 200CD



KEY FEATURES

- No Zero Setting ✓
- Constant Output ✓
- Wide Frequency Range ✓
- Logarithmic Scale ✓
- Lower Distortion ✓
- with H20-200 CD ✓

USE IT FOR:

- Amplifier Testing
- Bridge Source
- Modulating Signal Generators
- Servo Systems
- Sonar Apparatus
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- Carrier Telephone Eqpt.
- Transmission Lines
- Resonance Demonstrations
- Instrument Calibration

SPECIFICATION	200 CD	H20 - 200 CD
Frequency range:	5 hz — 500 khz	5 hz — 500 khz
Calibration Accuracy:	± 2%	± 2%
Power Output:	160 MW (600 Ω)	93.5 (600 Ω)
Voltage Output:	10 V (600 Ω)	7.5 (500 Ω)
Distortion:	0.5% below 500 khz	< 0.05%, 750 hz: 20-50 hz < 0.1%
Hum & Noise:	0.1%	< 0.5%, 5 to 20 hz
Frequency Response:	± 1 dB	± 1 dB
Output Impedance:	600 Ω	600 Ω

If you have a hp 200 CD and require the new specification write to us for the service note describing these modifications. We can modify your oscillator to THIS specification.

PRICES N.Z.; 200 CD £112/7/0 — $225.40 **H20-200 CD £129/2/0 — $258.40**

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CONSULTANT EDITORS:
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I. H. Spackman, A.M.I.E.E.E.
P. L. Watts representing N.Z. Electronics Institute
EXECUTIVE EDITOR:
Robin H. E. Beckett.

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Director and Chairman:
Victor L. Beckett A.A.I.(Aust.) Hon.A.N.Z.I.A.
Director and Secretary:
Wilma W. Beckett
Production Manager:
Robin H. E. Beckett, B.A.
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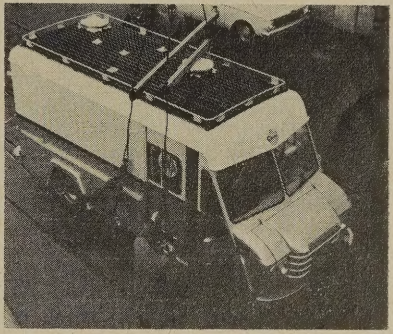


Sports and other outside activities are now being telecast direct from the new Marconi two-camera television vehicle which has gone into service at DNTV-2. One of the first of such broadcasts was the Springbok/New Zealand rugby test match at Carisbrook, Dunedin.

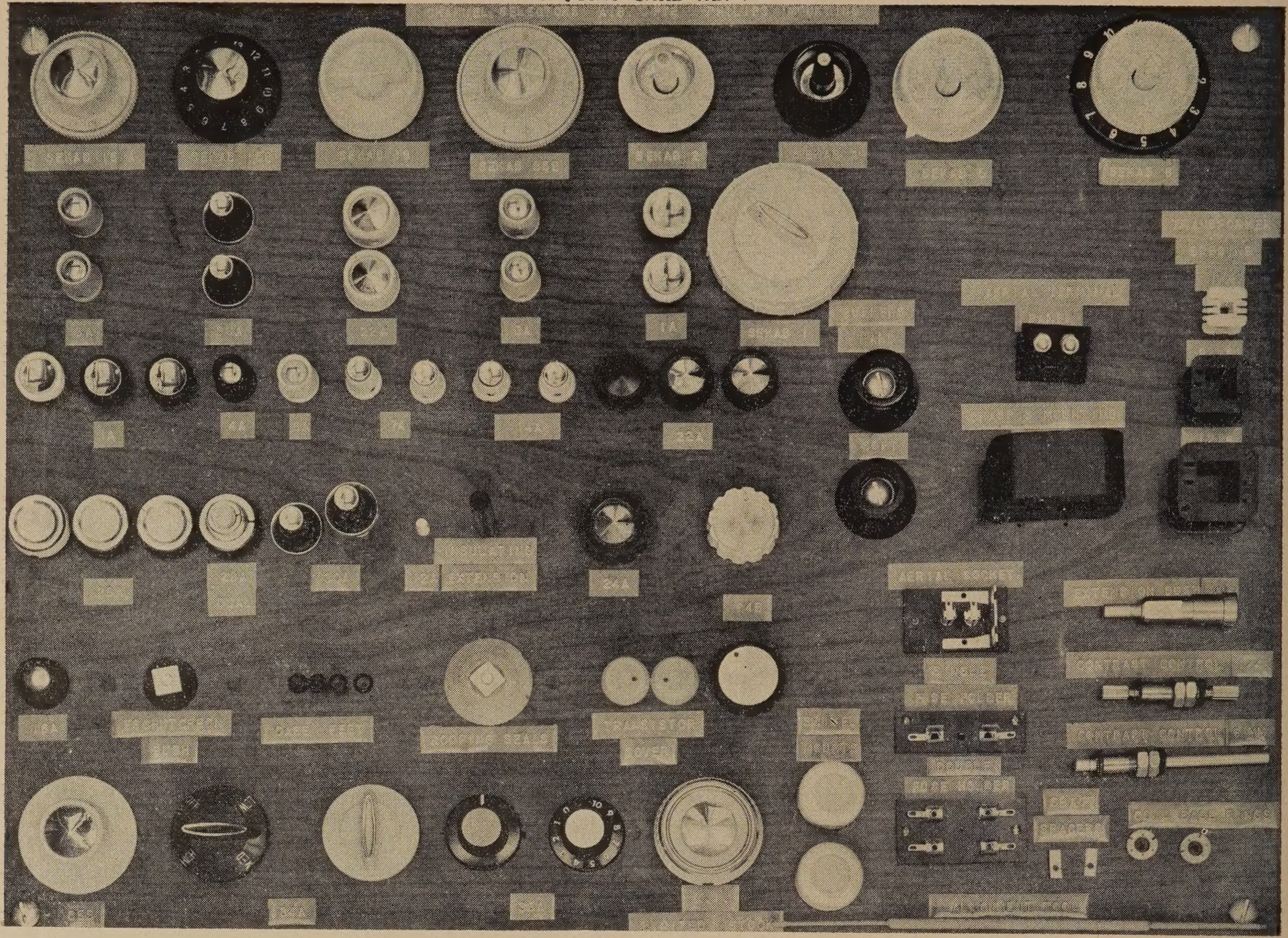
This van is equipped with Marconi Mark IV 4½" Image Orthicon cameras similar to those used in the DNTV-2 studios. Other main centres at Auckland, Wellington and Christchurch use Marconi four-camera television OB vans which were supplied by Amalgamated Wireless (Australasia) N.Z. Limited.

ENQUIRY CARD AD. 6

COMING . . .
A fast rise quadruple pulse generator.
Communication receiver design.
Mobile communication — part VII.
Acoustic instrumentation.
The choice of oscilloscope probes.
A look at signal generators.
V.L.F. propagation — part II.
Special Avionic feature.

ALSO . . .
Laboratory report.
Listening Post
Camera View.
Circuit and service data.
New Products.
Book Reviews.
Serviceman's Column.

ENQUIRY CARD AD. 7



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The illustration shows some of the quality injection moulding available

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Letters to the Editor

Sir,

In reply to your letter dated 28-6-65 I was interested in obtaining service data for the Autocrat Vega Altair TV receiver.

If this is not available I would like a copy of Radio, Electronics & Communications April 1965 issue.

J. B. MANSON,
Invercargill.

A photo-copy of the service data has been sent and also the issue you sought.

Sir,

Could you possibly supply me with a back number of R. & E. — October 1952.

I am building the "R. & E." .807 standard amplifier since I have the tubes available.

E. RHODES,
Wellington.

We have sent photo-copies of the article you were after in October issue — we do not have copies for sale prior to April 1961. Where possible we will obtain photo-copies of earlier articles.

Courses for Radio and Electronic Qualifications — 1966

Following investigation by the Institution of Electronic and Radio Engineers, London, of the New Zealand Certificate in Engineering, advice has been received that holders of the N.Z.C.E. in Telecommunications can apply for exemption from Part A of the Institution's Examination. At the time of going to press this exemption applies to those candidates who studied for their N.Z.C.E. at the Auckland Technical Institute but it is expected that southern technical institutes will be similarly approved in the New Year.

The exemption is provisional and has been granted to enable a more accurate assessment of the N.Z.C.E. to be made and continued exemption will depend upon the performance of candidates in Part B.

The Auckland Technical Institute plans to run a course for Section B in 1966. This requires four subjects simultaneously and A.T.I. indicates that 8 hours weekly may be required — divided equally between day and evening classes.

Intending candidates should approach the A.T.I. (attention Mr. R. B. Waddell, Head of Applied Science Dept.) so that courses can be planned for 1966, especially in specialist subjects.

The C.R.T. Examination

This examination is being replaced in 1966 with a new qualification called the Radio Technicians Certificate (R.T.C.). This will provide a more comprehensive course of training than that required for the relatively simple C.R.T. examination it replaces.

Students with School Certificate passes in Mathematics and Physics will be required to undertake a part-time course lasting two years and requiring a weekly attendance of at least four hours at a technical institute. For those who can attend, block courses of nine weeks duration are available for this course.

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ENQUIRY CARD AD. 16

ENQUIRY CARD AD. 8

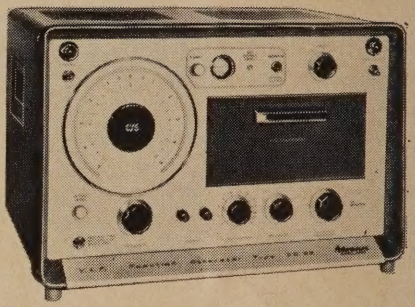
Advance

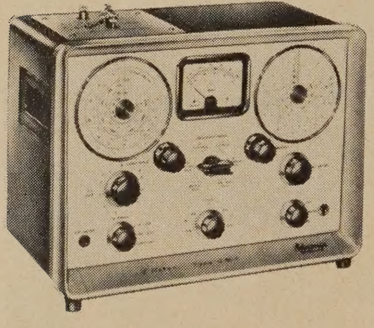
v.l.f. function generator & Q meters

SG88

V.L.F. Function Generator

Frequency range 0·005c/s to 50c/s for single cycle disc. Higher frequency is possible by use of 2, 3 or 4, etc., cycle disc. *Calibration* ±1% full scale. *Output* VOLTAGE Continuously variable from 200μV to 22V pk.pk. AMPLITUDE VARIATION Within 1dB over entire frequency range. IMPEDANCE At maximum output 6kΩ, mid setting 16kΩ, depending on frequency. WAVEFORMS Any single valued repetitive function. *Facilities* Direction of rotation of the waveform disc can be reversed, thus reversing the time sequence of the waveform. Automatic frequency sweep device on the 0·5 to 5c/s and 5 to 50c/s bands. Sweep time is approximately 2 minutes for any 10: 1 frequency excursion. Four waveform discs (sine, square, sawtooth and white noise) and one blank disc supplied. Special discs made to order. *Power requirements* 105 to 125V, 190 to 250V, 50 to 60c/s, 165W. *Dimensions* 19¾in (50cm) wide × 13in (33cm) high × 15in (38cm) deep. *Weight* 80lb (36kg).





CM1

'Q' Meter

'Q' range 15 to 600 in two bands. *Oscillator frequency* 100kc/s to 100Mc/s in six bands. *Frequency accuracy* ±1%. Stabilised signal level. *Main capacitors* Capacitor scales 10 to 70pF (±1pF), 40 to 600pF (±2%). Reactance (Xf) scales 16000 to 2200Ω–Mc/s; 4000 to 300Ω–Mc/s. Inductance (Lf^2) scales 2500 to 350μH–Mc/s^2; 600 to 50μH–Mc/s^2. *Incremental capacitor* ±5pF (on 40 to 600pF range of main capacitor) in divisions of 0·2pF. *Accuracy of inductance measurement* ±(5% + residual inductance of 0·035μH). *'Q' range* 15 to 150, 60 to 600. *Accuracy* ±(5% + 5% F.S.D.) below 50Mc/s. For frequencies above 50Mc/s and 'Q' readings above 400 the tolerance should be doubled. *'% Q' scale* Range ±10% (relative to nominal 'Q' reading). *Power requirements* 105 to 125V, 195 to 225V, 225 to 260V, 50c/s (models to suit other frequencies can be supplied). *Dimensions* 18in (46cm) wide × 14in (35·5cm) high × 9½in (24cm) deep. *Weight* 38lb (17kg).

T2

'Q' Meter

'Q' range 10 to 400 in two bands. *Accuracy* ±(5% + 5% F.S.D.) below 50Mc/s. *Oscillator frequency* 100kc/s to 100Mc/s in six bands. *Accuracy* ±1%. *Main capacitors* Capacitor scale 40 to 550pF (±2%). Reactance (Xf) scale 4000 to 300Ω–Mc/s (±2%). Inductance (Lf^2) scale 600 to 50μH–Mc/s^2 (±2%). *Incremental capacitor* 2·5pF. *Accuracy of inductance measurement* ±(5% + residual inductance of 0·03μH). *'% Q' scale* Range 10% (relative to normal 'Q' reading). *Accuracy* ±1% (i.e. ±1 division up to 50Mc/s). *Power requirements* *110 to 120V, 200 to 210V, 220 to 230V, 240 to 250V, 40 to 60c/s, 20W. *Dimensions* 15½in (39cm) wide × 10¼in (26cm) high × 6½in (16·5cm) deep.

Weight 14lb (6·5kg).
**Special model available T2E 110 to 125V, 130 to 140V, 160V, 220V, 40 to 60c/s.*

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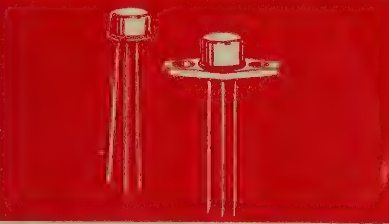
ENQUIRY CARD AD. 9

RCA's Broad Economy Silicon Line Offers Blocking Voltages to 450 V Currents to 30 Amperes



TO-5 AND FLANGED TO-5
I_c MAX to 1 AMP . P_t MAX = 5 and 10 W

TO-66 PKG.
I_c MAX to 4 AMP . P_t MAX = 29 W

TO-3 PKG.
I_c MAX to 15 AMP . P_t MAX = 117 W

TO-3 PKG.
I_c MAX to 30 AMP . P_t MAX = 150W

12-Volt Supply/Inverter Power to 350 W/Audio Power to 100W/ Regulators Short-Circuit-Proof to 150W	Medium-Voltage/Inverter Power to 800 W/Audio Power to 300W/ Regulators Short-Circuit-Proof to 150W	High Voltage High Transients Inverter Power to 1KW Audio Power to 300W Regulators Short-Circuit-Proof to 150W
RCA 2N3053 V_{CEV} max 60V h_{FE} @ I_c = 150 ma 50-250 f_T 100 Mc (min)		**RCA 2N3440** V_{CEO} (sus) min 250V h_{FE} @ I_c = 20 ma 40-160 f_T 20 Mc (min) **RCA 40256** (TO-5 w/flange) $\theta_{j\text{-}c}$ = 15° C/W
RCA 40250 V_{CEV} max 50V h_{FE} @ I_c = 1.5A 25-100 f_T (typ) 1 Mc	**RCA 2N3054** V_{CEV} max 90V h_{FE} @ I_c = 0.5A 25-100 f_T (typ) 1 Mc	**RCA 2N3441** V_{CEV} max 160V h_{FE} @ I_c = 0.5 Adc 20-80 f_T (typ) 0.8 Mc
RCA 40251 V_{CEV} 50V h_{FE} @ I_c = 8A 15-60 f_T (typ) 0.5 Mc	**RCA 2N3055** V_{CEV} 100V h_{FE} @ I_c = 4A 20-70 f_T (typ) 0.5 Mc	**RCA 2N3442** V_{CEV} 160V h_{FE} @ I_c = 3Adc 20-70 f_T (typ) 0.6 Mc
RCA TA-2650 V_{CEO} 40V h_{FE} @ I_c = 15A 15-60 f_T (typ) 700 Kc	**RCA TA-2544** V_{CEO} 60V h_{FE} @ I_c = 10A 15-60 f_T (typ) 700 Kc	**RCA TA-2645A** V_{CEO} 140V h_{FE} @ I_c = 8A 15-60 f_T (typ) 500 Kc

RCA announce economy silicon power range up to 30 amps

Included in the standard range are types recommended for 12-volt supplies, and medium and high voltage applications. For economy and performance, check the line of RCA silicon power transistors now available from AWA.

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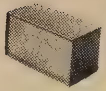
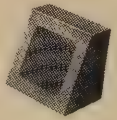
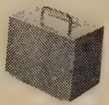
VR.26

ENQUIRY CARD AD. 10

Chassis and Cabinets







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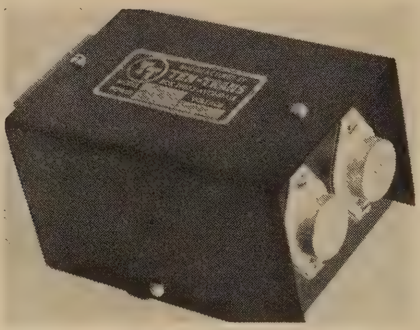

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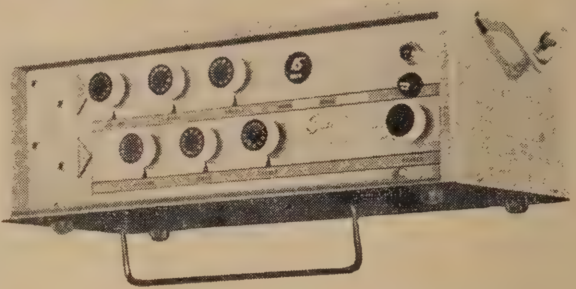

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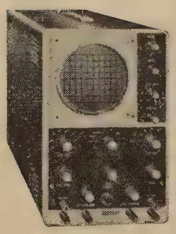

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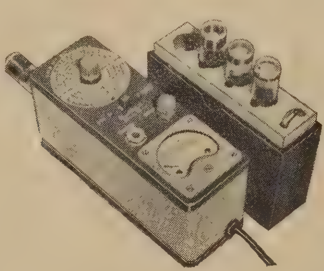

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Some Puzzles of Propagation

Radio propagation in all parts of the electromagnetic spectrum, remains the subject of much research, being in many cases of more than passing interest to the communications engineer. It has been said that the anomolies and freak results of yesterday provide the reliable commercial communication links of tomorrow.

One example of this is to be found in the range of frequencies below 25 kilocycles per second. V.L.F. communications has been raised from the doldrums to meet the need for providing highly accurate methods for comparison of time and frequency standards, and for communication to vehicles both under the surface of the sea, and outside the region of the ionosphere.

A second example is the growth of TV broadcasting on V.H.F. and U.H.F. channels which requires much more knowledge of propagation beyond the horizon, for without this knowledge, even in this country television broadcasting can run into difficulties with co-channel interference.

One typical problem is the allocation of the same channel to both AK.TV2 in Auckland and DN.TV2 in Dunedin. Even before TV was introduced into this country, it was known that under suitable propagation conditions by means of "sporadic E" ionization, signals in the lower V.H.F. spectrum were propagated up and down the country with very little attenuations of signal over distances of 800 to 1500 miles. The TV stations in Auckland and Dunedin are almost ideally located for this type of propagation effect to occur. Consequently viewers have already experienced co-channel interference between these two stations, and others in Australia at the same distance during the summer months.

As we go to press, Australian TV stations are becoming audible and viewable, and causing interference to local stations, and conversely the reverse condition is also occurring, that is, Australian TV stations are being affected by signals propagated from New Zealand.

With the character, duration and intensity of the next sunspot maximum, which is due about 1969, still very much unknown, and in view of the fact that the last cycle peak in 1957/58, was the highest ever recorded during periods of observations dating back many hundreds of years, there is a likelihood that in the next two or three years, co-channel interference could become more common. Unfortunately, however, there is little to be done to obviate such problems except shifting the frequencies of the stations or, in some localities the use of highly directional antennas by the viewers.

Consequently, those technical people dealing or working in the TV industry, and who are dealing with the public, should make themselves thoroughly familiar with the causes and effects of co-channel interference and be able satisfactorily to explain to the possibly "irate" viewer what is happening, and why.

I.H.S.

The Launching of OSCAR 4

The Editor has just received from The "Oscar Associations" Headquarters some news of the proposed launching of Oscar 4. The Association has been invited to submit a Radio Satellite for launching on a Titan 3 Research and Development vehicle some time in the early part of December, 1965. Six and a half hours after "blast-off" at a height of 18,200 miles, the Oscar satellite is to be injected into a semi-synchronous orbit above the equator over Ecuador. The path of the satellite is at an angle of 0 degrees to the equator, drifting slowly eastward about 30 degrees per day, and will be visible from all points lying up to 81 degrees north and south of the equator. The satellite is intended to be spin stabilised with its transmitting antennae parallel to the axis of the earth, and fully solar powered with a life expectancy of up to one year.

A number of proposed satellites are being tested and evaluated for final selection at the time of writing.

Two of these are multiband beacons operating on three frequencies of 144.05 mc/s, 432.15 mc/s and 1296.45 mc/s, with an output of 1 watt on each channel.

The most pretentious (and most desirable) project being tested is a linear translator package receiving on 144.1 mcs and transmitting of 431.935 mc/s, with peak output of 3 watts translating a channel 10 kc wide. This translator is to be accompanied by a beacon on 431.920 mc/s, which will be gated on for about one minute in every ten, sending a carrier and the approved identification by the letters H.I. sent in morse code.

This is obviously the most pretentious and interesting Oscar Project to date, and further information will be published in this journal as it comes to hand.

I.H.S.

Development and Research on Very Low Frequency Propagation

by G. J. Burt, B.A. (Oxon). Physics and Engineering Laboratory, D.S.I.R., Lower Hutt

By definition the V.L.F. band in the radio frequency spectrum extends from 3 to 30 Kc/s. For most practical purposes, however, interest is restricted to the band 10-30 Kc/s. This band has been used for wireless telegraphy communications from quite early times. In 1925 for example, a research team from the Marconi Company reported their results of a round-the-world voyage investigating the performance of something like twenty V.L.F. transmitters received at long ranges. (1)

The principal advantage of using this band was that signals could be received with great reliability over a great range of distances and virtually at all times. There was no evidence of interruption or deterioration in a circuit due to disturbed conditions, nor was it necessary to use a number of frequencies to cope with changing conditions of day or night over the path, as was the case with "short wave" circuits. There was an additional property of these frequencies, of interest in naval communications; these signals could be received at a reasonable range by submarines using aerials that were submerged just below the sea surface.

One disadvantage of using these frequencies lies in the enormous and expensive amplifier and aerial systems necessary to radiate a significant amount of power. For example the published cost for the main contract for building the new V.L.F. station for NATO at Anthorn in Cumberland (U.K.) was £3¾ million. Another serious disadvantage is the very restricted bandwidth available using V.L.F. It was for these reasons, that in the development of long distance radio communications V.L.F. was virtually abandoned in favour of the "short wave" band.

The spur given to radio and electronic research by the 1939-1945 war produced two developments which have led to a renewed interest in the V.L.F. band in recent years. The great advances in the development of stable radio frequency oscillators controlled by quartz crystals and later by so-called "atomic" frequency standards meant that radio frequency standards of greatly improved accuracy were set up all over the world, and with this came the problem of inter-comparing these standards. Also during the war were developed a number of radio navigational aids including the so-called hyperbolic grid systems, such as GEE, LORAN and DECCA. The more precise of these systems require the comparison of the phases of signals from pairs of phase locked transmitters, measured at considerable distance from the stations.

The properties of V.L.F. transmissions make them particularly suitable for both these purposes. At the present time a considerable number of relatively high powered V.L.F. stations are frequency stabilised to within very close limits in relation to national standards of frequency. These provide the best means so far of promulgating standard frequencies to an accuracy of the order of several parts in 10^{10}. At the present time a great deal of money and effort is being spent in the development of navigational systems using V.L.F. transmissions.

Transmission Below the Ionosphere

The earlier investigations on propagation in this band were almost entirely concerned with the signal

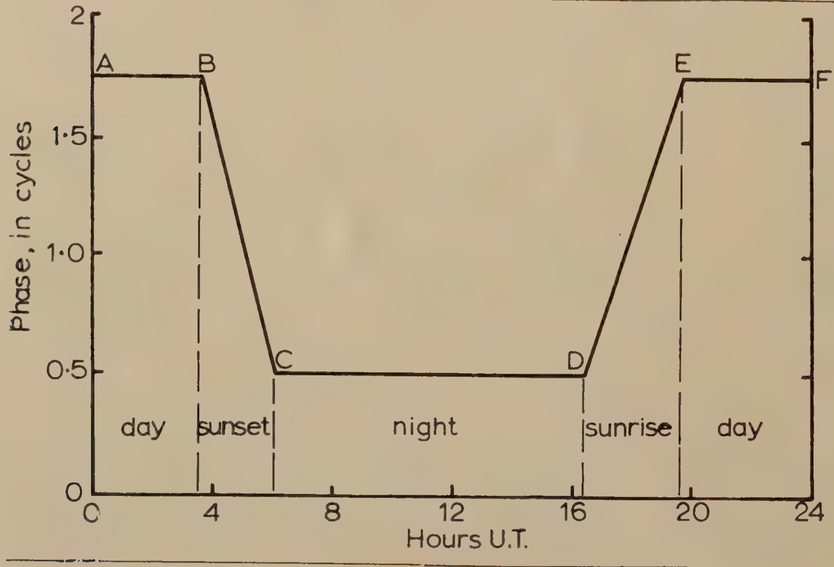

Figure one: Theoretical Pattern of Phase Change for a Signal from GBR (Rugby) as Received in New Zealand.

strength of transmissions in terms of the radiated power of the transmitter, the length of the path and such factors as the difference between day and night conditions over the path. It is interesting to note that in 1925 Eckersley and his colleagues (1) were able to show agreement in their observations with an hypothesis produced by G. N. Watson that these waves are propagated in a duct or wave guide formed by the earth's surface and the lower boundary of the Heaviside Layer. They showed also that differences in signal strength could be explained by differences in the height of the layer and differences in the reflection coefficients of both the lower boundary of the duct — the earth's surface, and the upper boundary — the bottom of the Heaviside Layer.

In the late 1940's several workers in the United States and in Britain became interested in the phase stability of V.L.F. signals when propagated over fairly long distances. There is no doubt that some of the interest in this matter arose from suggestions that a long range position fixing navigational system might be developed using these frequencies. At this time the Decca Navigator System had been set up in Western Europe with considerable success. This used phase-locked C.W. signals in the 100 Kc/s band, and its range was limited to a few hundred miles as an accurate system because of sky wave interference, particularly at night.

However, the transmission of standard frequencies was also involved, since the two ideas were technically inter-related. A phase comparison navigational system must use signals that are accurately frequency stabilised, and any reliable investigations on the phase stability of signals at long distances must be made on a transmitter whose frequency variations are small in comparison with any propagational variations being measured.

In 1954 the 16 Kc/s carrier of the British Post Office station at Rugby (G.B.R.) was frequency controlled using an oscillator with a stability of the order of a few parts in 10^{10}, and J. A. Pierce at Harvard University was able to make frequency comparison measurements with an accuracy at times of something like 1 part in 10^9, but deteriorating during some periods of the day to about 3 parts in 10^9. (2)

In 1950-51 a New Zealand frequency standard had been set up in the Dominion Physical Laboratory, but work with this standard was considerably handicapped because comparison with overseas standards could only be made using H.F. transmissions, and as received in New Zealand, they were considerably less stable than the known performance of the local standard oscillators. The information that the GBR signals were received with useful stability on a trans-Atlantic path gave hope for making use of these signals in New Zealand, and a programme of observations was set up. A narrow band tuned amplifier was used to receive the GBR signal and the output mixed with a 16 Kc/s derived from one of the standard frequency 100 Kc/s oscillators. Observations were made on the resultant beat frequency, and early in 1956 Allan, Crombie and Penton were able to show that the frequency of GBR as received in New Zealand was stable over the greater part of the day to about 4 parts in 10^9. However, there were periods following local (New Zealand) sunrise and sunset when the frequency shifted by as much as 2 parts in 10^8. (3)

This work was continued with improvements in technique and in 1958, a paper by Allan, Crombie and Newman showed that the diurnal behaviour of phase stability of the GBR signal measured in New Zealand followed a pattern shown in idealised trapezoidal form in Figure 1. (4)

The sections of the curve AB and EF are periods when the short great circle path between transmitter and receiver is predominantly in daylight, and the period CD when it is in darkness. The period of phase lag BC corresponded with the transition from day to night over the path, and the period DE to the advance of sunrise along the path. These results were in agreement with measurements made by Pierce at Harvard on a path across the Atlantic. The figure for the night-to-day phase change per unit distance of path agreed with Pierce — the relative steepness of the phase changes in BC and DE corresponded with the relative advance rates of the sunset and sunrise lines over the path. The overall change in phase between the ABEF daytime level and CD night time level was calculated to correspond to a change in the effective height of the base of the ionosphere from 70 Kms to 80 Kms — also in agreement with the Trans-Atlantic results.

One point of particular interest in this work was that the results seemed to show that the predominant signal was that travelling by the short great circle path. The signals via the long great circle path would have diurnal changes approximately 12 hours out of phase with those of the short path signals and there was no evidence of any such superimposed effects. Since the short great circle path is 18,500 Kms and the long path only 21,500 Kms this appeared surprising.

Eckersley and his colleagues in their early work had shown some evidence that V.L.F. signals propagated in a direction West to East were less attenuated than those travelling East to West. In 1958 in New Zealand Crombie made a series of observations of the station NSS in Washington. The short great circle path to Wellington from NSS (14000 Kms) arrives from a direction 18° North of East. Using directional receiving aerials Crombie showed that for many hours of the day the long path signal (26000 Kms) arrived in New Zealand with a strength at least as great as the short path signal. This work was followed up in 1959 by a thorough theoretical treatment by Barber and Crombie of the effect of the earth's magnetic field on the propagation of V.L.F. waves. (5) It was shown that there was a significantly greater attenuation factor for signals travelling transversely to the earth's magnetic field lines to the West, compared with those travelling to the East.

In 1963 the author published the results of measurements made on station NBA (Panama). (6)

The short great circle path (12000 Kms) from this station arrives in New Zealand from almost due East. The diurnal phase pattern for this station showed some agreement with what might be expected for the short great circle path signal, but there were frequent anomalies, and on some occasions there were fairly rapid phase changes of 360° which did not recover during the 24 hour period, and were referred to as “cycle slips”. It was suggested that “cycle slipping” could occur because of the temporary dominance of the long great circle path signal at times when the sunrise or sunset transit was causing rapid phase change on the short path signal. These results were confirmed by Thompson and his colleagues in a paper published in the same month, (7) also dealing with the behaviour of NBA, but over a Panama to Sydney path. Thompson experienced cycle slipping but he also was able to differentiate between the long and short great circle signals, and showed an example of cycle slipping on a short path signal that was free of long path interference. This he suggested was the result of interference between signals travelling by different wave guide modes over the same path. The idea of multi-mode interference has been developed further by Crombie and others at the National Bureau of Standards in Colorado, where, working over somewhat shorter paths they have demonstrated the effects of multimode interference during the transit of the sunrise and sunset lines across the transmission paths, and have produced a working hypothesis to explain these effects.

V.L.F. Transmission in the “Whistler Mode”

So far we have dealt only with V.L.F. signals transmitted in the region of the earth's atmosphere below the ionosphere. However, in 1953 Storey published a theoretical paper (8) on radio “whistlers” in which he postulated that radio energy in the V.L.F. band could be transmitted over long distances, passing through the ionosphere and following the lines of the earth's magnetic field in the region now referred to as the magnetosphere. Confirmation of this hypothesis was provided in 1956 by Allcock in New Zealand and Morgan, of Dartmouth College, New Hampshire who observed the transmission of “whistlers” (radio emissions from a lightning flash) backwards and forwards between two magnetically conjugate stations in Lower Hutt, New Zealand and in the Aleutian Islands. (9)

This was the beginning of a period of considerable activity in several parts of the world concerned with the propagation of these naturally occurring whistler signals. In 1958 workers at Stanford University published the results of observations made on signals from one of the V.L.F. stations in the northern hemisphere (NSS) using a receiving station close to the magnetic conjugate of NSS. (10) Not only was the normal signal travelling by the sub-ionospheric path observed, but at times there was a reasonably strong signal travelling by the “whistler” path. This work has been carried a great deal further, particularly by Allan, Allcock and McNeill working in New Zealand, (11 and 12) and it is now recognised that V.L.F. signals that have travelled by complex paths involving both “whistler” mode and sub-ionosphere mode can be received at recordable levels. For example, signals from NPG in Seattle are regularly received in New Zealand via the whistler mode although the magnetic conjugate of Seattle is well over two thousand kilometres east of New Zealand. These signals are normally much weaker than those received by the more direct sub-ionosphere path, but at times they can rise to a comparable signal level. The frequency or phase variations of these signals are relatively enormous, due to the variable conditions which must exist in the whistler path. Doppler frequency shifts on these signals of many parts in 10^6 are commonly observed — compared with the normal maximum Doppler of a part or so in 10^8 on the sub-ionosphere path. The extent to which these whistler mode signals could cause significant interference to V.L.F. reception for frequency standard or navigational purposes has yet to be examined closely, but it is clear at this stage that there are circumstances in which it cannot be ignored.

Conclusions

V.L.F. radio transmissions provide a valuable means of conveying previse frequency and phase information over long distances. Considerably more world wide studies are needed to determine the limitations to this method set by propagation performance. These studies, of course, will also provide further information on the nature and behaviour of the lower ionosphere. The study of V.L.F. whistler mode propagation is basically concerned with research into the nature and behaviour of the upper atmosphere including the ionosphere and the magnetosphere. However, it has an immediate practical relevance in determining the “nuisance” value of whistler mode signals in relation to precise phase and frequency measurements using V.L.F. sub-ionosphere propagation.

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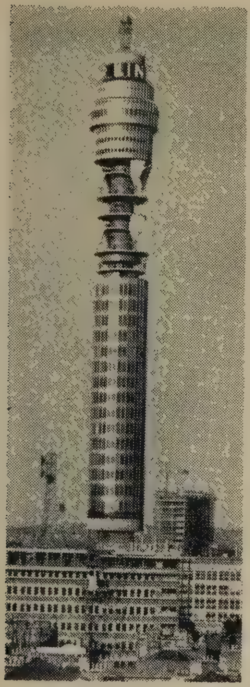


The London Post Office Tower

By P. J. Edwards, A.M.I.E.E.
(General Post Office Engineering Department)

Providing a new feature on the London skyline, the Post Office Tower will be the London terminal of a nation-wide trunk network of microwave radio-relay links for carrying telephone, television and industrial traffic.

In the period since World War II, the General Post Office has provided a network of underground co-axial cable and microwave radio-relay links to serve the British Broadcasting Corporation and the Independent Television Authority 405-line monochrome television services. The radio components of the network provide an aggregate length of 4,000 operational video-channel miles with a London terminal located adjacent to and in the shadow of the new tower. In the same period, steady developments in microwave techniques have enabled the G.P.O. to introduce radio links as viable alternatives to co-axial cable links for long-distance transmission of multi-channel telephony.

Rapid expansion and reconstruction of the radio network is now being undertaken to meet the requirements of the B.B.C's 625-line television service, and to provide extensive trunk telephone circuit capacity to meet the increasing use of telephones which is expected to be further stimulated by the spread of subscriber trunk dialling. A prime example of the reconstruction now under way is the replacement of the existing radio terminal in London, which has neither the communication capacity nor the communication security required for future needs.

By 1966, a trunk network of radio-relay links, with an aggregate route length of 2,000 miles and using 120 stations, will link all Britain's main centres of population. In addition to providing for the needs of the present 405-line services, the network will provide 2,100 operational video-channel miles to serve the first 13 U.H.F. 625-line television broadcast transmitters. An important requirement has been the need to cater for the eventual transmission of colour signals; in the absence of international agreement on a colour system, the G.P.O. has specified transmission standards appropriate to the National Television System Committee (N.T.S.C.) system which is considered to have the most stringent requirements of any of the colour systems which might be adopted.

The network will also provide about 4,500 miles of operational broadband channels for the transmission of multi-channel telephony. Of this, 900 channel miles will have a capacity of 300 or 600 telephone channels per broadband. 1,800 miles will have a capacity of 960 telephone channels per broadband channel and 1,800 miles a capacity of 1,800 telephone channels per broadband channel. At the present time, the aggregate telephone circuit mileage carried by radio links is 230,000, but by 1966 this will have increased to 2,500,000.

The station which must cater for the greatest demand for broadband circuits is the Post Office tower, where important trunk telephone exchanges are concentrated and the London network of local television cables converges. The station will also carry traffic to mainland Europe by way of a cross-channel radio link and to North America by way of the Satellite Ground Station at Goonhilly Down, Cornwall.

Microwave radio-relay links now in use operate in radio frequency bands centred on 2,000, 4,000 and 6,250 Mc/s, and a further band centred on 6,800 Mc/s will shortly be brought into

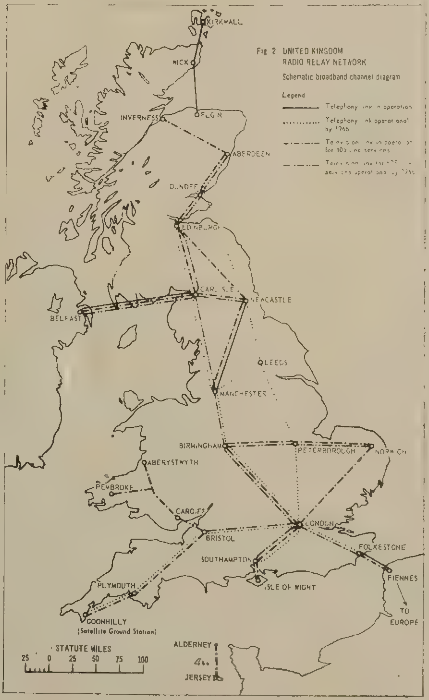


Fig 2 UNITED KINGDOOM RADIO RELAY NETWORK
Schematic broadband channel diagram

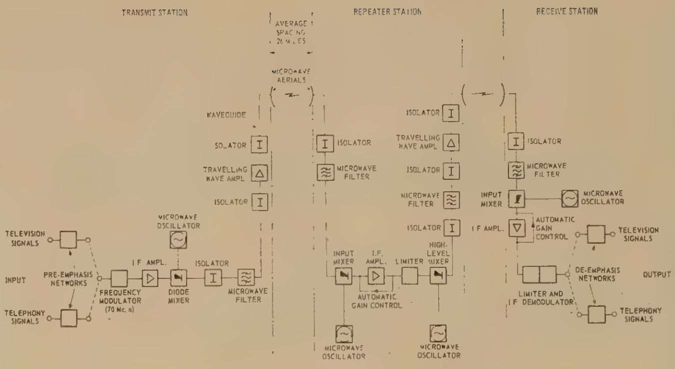


Fig. 3: Single broadband channel radio link for 960 speech channels or television.

use; many individual broadband channels can be accommodated in each of these bands. Radio energy is propagated in narrow beams by highly directional aerials along "line-of-sight" paths between stations, which have an average separation of about 26 miles.

Substantially "free - space" propagation between adjacent stations must be achieved for all but a small percentage of time. To meet this criterion there must be a certain minimum clearance between the direct transmission path of the microwave energy and the ground or obstructions on or near the transmission path, so as to avoid diffraction losses. To achieve this, the microwave paths are planned to clear the ground or any other potential obstructions by about one half the radius of the first "Fresnel zone". In practice, the required clearance ranges from a few feet at the ends of the path to 100 feet or more at mid-path.

The microwave energy does not, however, necessarily travel in a straight line. The lower atmosphere is not homogeneous, and there is a gradient in refractive index which varies with time and with height above ground. Although small, this gradient can produce significant bending in the wave path. Under what is known as "standard" refraction conditions, the curvature of the path has the same sense as that of the earth's surface but the radius of curvature of the wave path is four times that of the radius of the earth's curvature. When planning links, it is most convenient to consider that the propagation will take place over straight-line paths and to adjust the geometry by regarding the earth as having an effective radius four-thirds of its actual radius under normal conditions. Abnormal propagation conditions occasionally arise where the gradient of the refractive index is such as to cause the wave path to have a curvature opposite to that of the surface of the earth, thus subjecting it to diffraction losses at obstacles normally well clear of the path.

To guard against these occasional adverse conditions, it has been assumed that the earth's radius is 0.7 of its actual value. The heights of trees and possible building development are added to the dominant obstacles to obtain the final effective height above which a clearance of about one-half Fresnel zone is required to maintain free-space propagation. For this reason the microwave aerials are, in all cases except the Post Office tower and a similar one now under construction in Birmingham, Warwickshire, supported on lattice steel or concrete structures at a height above ground of between 50 to 300 ft. In such cases the microwave radio equipment is housed in a single-story building at the foot of the tower, and connected to the aerials by means of waveguide transmission lines located within the tower's structure.

Danger of obstruction of radio paths by tall buildings poses special problems in cities such as London and Birmingham, where traffic requirements and economics indicate that the radio station should be at or near the geographic centre. In these special cases, the aerials must be mounted at a great height above ground, and the tower structure itself must accommodate the radio equipment so as to keep the length of the waveguide feeders conecting the aerials to the radio equipment as short as possible and hence the loss of microwave power to an acceptably small value.

Modern microwave transmission techniques and equipment can best be introduced by reference to a "hypothetical" single broadband channel link operating at 6,000 Mc/s and spanning about 50 miles by means of a single repeater station and providing one 625-line television channel, or 960 telephone channels, in an assembly of links installed, to provide most of the fixed gain and all of the reserve gain to overcome the inter-station transmission loss at the intermediate frequency, although some repeaters are in use in which all the amplification is carried out at radio frequency.

The low-noise input mixer (noise factor ten dB) serves to convert the signal to the amplifier with a IF maximum gain of 80 dB with automatic gain control to ensure constant output level for wide variations of input signal level. The amplifier bandwidth is plus or minus 20 Mc/s to three dB points and linear variations in group-delay do not exceed 0.05 nanoseconds per megacycle over the central 20 Mc/s of bandwidth. A high level mixer re-converts the signal to a microwave frequency which differs by 252 Mc/s from the signal frequency at the input to the repeater.

At the receiving station the signal is converted to IF, amplified to a fixed level, and fed to a limiter which serves to remove all residual A.M. components from the FM signal. Frequency/voltage conversion is carried out in a highly linear IF demodulator, the output of which is passed to an appropriate de-emphasis network (either for television or telephony), whose characteristic is the inverse of the pre-emphasis network at the transmitting station.

Initial traffic to be carried by the Post Office Tower is such that many RF broadband channels will be required on each of the main traffic routes the tower will serve. From an economic standpoint it is important for common equipment to be shared by as many channels as possible and to this end a feature of the aerial gallery of the tower will be the use of the horn-reflector aerial.

The aerial, 27 feet high, 14 feet wide, and weighing one ton (see Fig. 5) consists of a parabolic reflector fed by a pyramidal horn with its axis vertical and its apex coincident with the focal point of the reflector; the radiating aperture is 140 square feet and is closed by a Hypalon coated Terylene sheet thus allowing the aerial and its associated waveguide to be pressurised by dry air to prevent the ingress of moisture.

The aerial has extremely good matching properties. Its gain at 6,000 Mc/s is 45 dB relative to an isotropic radiator and it will be used to provide a transmission capacity of 1,800 telephone channels per RF carrier; a smaller version with an aperture area of 70 square feet and gain 42 dB will be used where the transmission capacity need not exceed 960 telephone channels per RF carrier.

The aerial has been designed to transmit and receive two signals, polarised at 90 degrees, when used in conjunction with low-loss 3'' diameter waveguide. In the Post Office Tower installation a pair of such aerials will be used for simultaneous transmission and reception of eight two-way RF carriers in the frequency band 5,925 - 6,425 Mc/s and six two-way carriers in the frequency band 3,800 - 4,200 Mc/s.

The 5,925 - 6,425 Mc/s communications band, 500 Mc/s wide, is sub-divided into two adjacent blocks of 250 Mc/s designated ''high'' and ''low'' for convenience. Each block contains eight radio frequency channels spaced 29.65 Mc/s apart and at any one station all transmit channels are located in one block (high or low) and all receive channels in the other (low or high); channels are interchanged from ''high'' to ''low'' or **vice-versa** by a frequency shift of 252 Mc/s during transmission through a repeater station.

This arrangement results in considerable economy in the use of the frequency spectrum and is only possible under certain conditions.

In general, this entails the use of four kc/s channels in the baseband frequency spectrum 60 kc/s - 4.028 Mc/s.

The baseband signal, after suitable pre-emphasis, frequency modulates an oscillator of mean centre frequency 70 Mc/s, the intermediate frequency. Pre-emphasis of the baseband signal before modulation and de-emphasis after demodulation are used to equalise the noise distribution in multi-channel telephony systems and to reduce distortion in television systems; it also enables identical modulators and identical demodulators to be used for both types of signal.

Peak-to-peak frequency deviation due to a television signal is eight Mc/s and the maximum R.M.S. deviation due to the multi-channel telephony signal is 1.1 Mc/s. The need for radio links to transmit telephony, as an alternative to television, stimulated intensive development by both the G.P.O. and Industry in the mid-1950's, and resulted in the production of IF modulators, demodulators and amplifiers of the high standards of performance required. The highly linear voltage/frequency transfer function of modulators (maximum variation of slope is 0.15 per cent. per Mc/s over 20 Mc/s band) was primarily required to minimise intermodulation noise in telephony systems but has subsequently enabled the increasingly stringent requirements of television transmission to be met.

The F.M. output signal of the modulator has a spectral range of 55 - 85 Mc/s and is amplified and applied together with a signal from a microwave oscillator to a crystal-diode mixer for conversion to microwave frequency. The microwave oscillator signal is derived from a 50 Mc/s crystal with subsequent frequency multiplication by means of transistor amplifiers and varactor diodes.

Mixer output consists of two FM sidebands, one above and one below the mean centre frequency of the microwave oscillator; each sideband carries all the essential information and one of them is selected by a band-pass microwave filter for application at a level of minus 29 decibels (dB) relative to one watt to a travelling wave amplifier of gain 36 dB.

The microwave signal at the output of the TWA (level plus seven dBW)is connected through a ferrite isolator and low-loss waveguide feeder to the microwave aerial. Echoes in FM systems give rise to intermodulation noise in telephony systems and distortion in television systems and must be reduced to an acceptable level. Ferrite isolators of the resonant or field displacement type exploit the special properties of ferrite materials to produce a non-reciprocal attenuation characteristic (forward loss

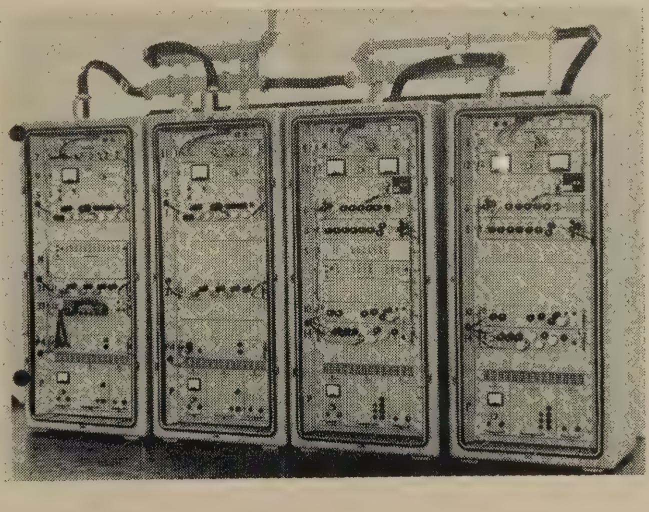


Fig. 4: 7,000 Mc/s transportable equipment in glass-fibre cabinets (for emergency telephone or television).

0.3 dB, reverse loss 30 dB) and are extensively used to reduce the level of echo signals arising from mis-matches between various microwave elements, for example waveguide feeder, transmitter and microwave aerial.

Total transmission loss between hypothetical aerials which radiate power uniformly in all directions (isotropic aerials), 25 miles apart in free space, is 140 dB. Practical microwave aerials are highly directional (plus or minus 0.7 degree to three dB power points) and have a gain of 42 dB, relative to isotropic aerials. Use of such aerials results in an overall transmission loss (including losses in waveguide feeders) of about 67 dB under normal propagation conditions. For all practical purposes this loss is constant over the radio frequency channel bandwidth of 30 Mc/s.

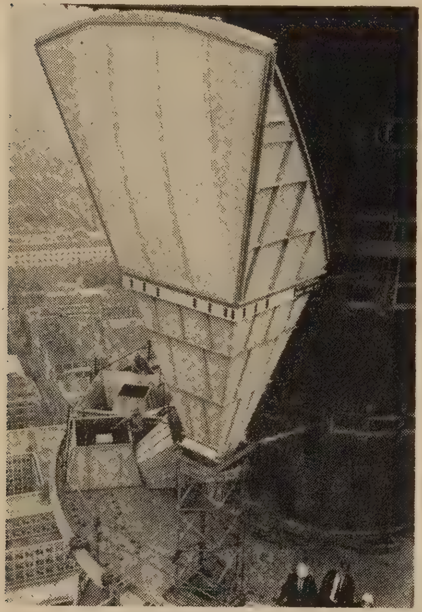


Fig. 5: A horn reflector aerial on the London Post-Office Tower.

Normal RF signal level at the repeater station input mixer is minus 60 dBW and this may fall to minus 90 dBW during periods of severe fading. It has been found convenient, in the majority of highly directional aerials and careful planing of the station to avoid unwanted local reflections. To enable channels to be separated more easily, adjacent channels are given orthogonal polarisation so that the minimum frequency spacing between two channels of the same polarisation is 59.3 Mc/s. A frequency gap of 44.5 Mc/s is provided between the transmit/receive blocks to facilitate the reduction of cross-talk. The directivity pattern of the horn-reflector aerial is such that RF channel assignments can be used simultaneously on each of the main routes from the Post Office Tower without significant cross-talk interference.

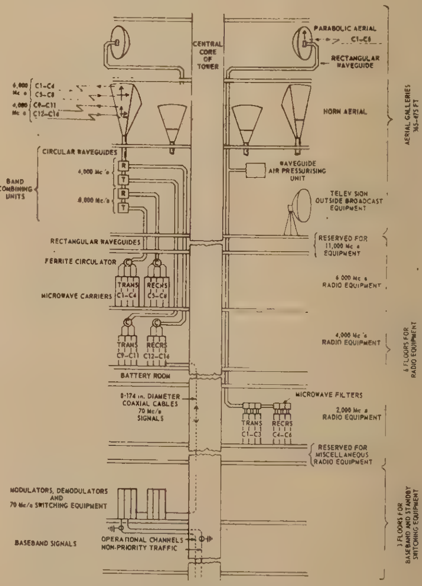
In the early years the tower in London will use six bands of frequencies in the range 1,700 Mcs to 11,700 Mc/s.

The full complement of RF broadband channels in the four and lower six gigacycles (Gc/s) bands will be carried by two horn aerials for each of the main routes; the upper six and eleven Gc/s together will probably use four parabolic-dish or two horn aerials for each route while the twoGc/s band will probably use two parabolic-dish aerials for each route. In addition, a further 14 parabolic dish aerials may be accommodated for spur routes and to meet future requirements.

The total main route capacity of the tower could be 150,000 telephone circuits if used entirely for telephony or 100 both-way television channels if used entirely for television. A more likely division is 25 both-way television channels and 125,000 telephone circuits. In addition, there will be a total capacity of 50,000 telephone circuits or 40 both-way television channels on spur routes, but it is possible that part of this capacity will be diverted to the main routes. The tower will also provide facilities for temporary microwave services such as television outside broadcasts and closed circuit television.

The aerials are accommodated on four circular galleries in the height range 365 to 475 feet and are connected to the radio equipment by way of waveguide feeders; these run down the outside surface of the hollow shaft which forms the central core of the tower, and for this purpose slots are provided in the equipment floors large enough for the 100 or so which will eventually be required. The microwave radio equipment will occupy the top six apparatus floors; the floor nearest the aerial gallery has been reserved for 11,000 Mc/s equipment and the remaining floors have been allocated on a descending height and frequency basis. Within each floor the equipment will be laid out in radial suites. Intermediate-frequency signals from these equipments will be connected by means of 0.174 inch (4.42 millimetre) diameter co-axial cables down the central core of the tower to modulating, demodulating and protection channel switching equipment housed in the next three floors. From there the baseband telephony and television signals will be taken by further co-axial cables down to the bottom of the tower and into an adjacent new building which will house a trunk telephone exchange and television switching centre.

In a few years it is likely that for telecommunications equipment including radio apparatus, valves will have been completely superseded by semi-conductor devices: indeed some of the radio equipment now on order for the tower will contain only a few valves and one travelling-wave tube. Such equipments will operate from low-voltage direct-current supplies, and two floors of the tower have been allocated for batteries and their associated rectifiers.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RECTANGULAR WAVEGUIDE
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C1–C4
C5–C8
4,000 Mc/s
C9–C11
C12–C14
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AERIAL GALLERIES 365–475 FT
CIRCULAR WAVEGUIDES
BAND COMBINING UNITS
4,000 Mc/s
R
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6,000 Mc/s
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T
WAVEGUIDE AIR PRESSURISING UNIT
TELEVISION OUTSIDE BROADCAST EQUIPMENT
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RESERVED FOR 11,000 Mc/s EQUIPMENT
FERRITE CIRCULATOR
TRANS C1–C4
RECRS C5–C8
MICROWAVE CARRIERS
6,000 Mc/s RADIO EQUIPMENT
TRANS C9–C11
RECRS C12–C14
4,000 Mc/s RADIO EQUIPMENT
6 FLOORS FOR RADIO EQUIPMENT
BATTERY ROOM
0·174 in. DIAMETER COAXIAL CABLES 70 Mc/s SIGNALS
MICROWAVE FILTERS
TRANS C1–C3
RECRS C4–C6
2,000 Mc/s RADIO EQUIPMENT
RESERVED FOR MISCELLANEOUS RADIO EQUIPMENT
MODULATORS, DEMODULATORS AND 70 Mc/s SWITCHING EQUIPMENT
BASEBAND SIGNALS
OPERATIONAL CHANNELS
NON-PRIORITY TRAFFIC
3 FLOORS FOR BASEBAND AND STANDBY SWITCHING EQUIPMENT

Fig. 6: Arrangement of radio equipment in the London Post-Office Tower.

CCIR Interim Study Group Meetings

Report from B. S. Furby

The International Radio Consultative Committee (CCIR) is a permanent organ of the International Telecommunications Union (ITU) and was set up to study technical and operating questions relating specifically to radio communication. The CCIR works through 14 Study Groups and a Plenary Assembly meeting normally every three years. The work of the various Study Groups is normally carried out by correspondence but when deemed essential interim study group meetings are held between Plenary Assemblies to complete work which it has not been possible to deal with by correspondence.

This year interim study group meetings of Study Group X (broadcasting) and Study Group XI (television) were held in Vienna. Some 230 delegates from 45 countries attended the meetings including a representative from the N.Z.B.C., Mr. L. H. Martin, A.M.I.E.E., Supervising Engineer Operations.

Study Group X under the chairmanship of Mr Prose Walker, Director of the Broadcast Communications Division, Collins Radio Company, dealt with a wide range of problems covering all aspects of broadcasting. These included recording of both sound and video as well as the important subject of international standards for public stereophonic broadcasting. The problems of transmitting two sound channels as an accompaniment to a single vision channel were also studied. In the custom of the CCIR, draft reports and recommendations were prepared for submission to the XIth Plenary Assembly to be held in Oslo in 1966.

Study Group XI under the chairmanship of Mr Erik Esping, Engineer in Chief of the Royal Board of Swedish Telecommunications, studied many matters of technical importance concerned with television operations and television standards including the definition of possible world standards for colour television. It was this subject that attracted most attention. The discussions in the interim meeting at Vienna bore on the choice of the same colour system for the countries of the world which have or will have the 625 line/50 field system. Extensive studies have been undertaken during the past two years by the EBU, the OIRT and many countries.

The three systems considered, NTSC, SECAM and PAL are fully compatible and can be used with the same types of colour cameras. Each system is capable of producing colour pictures of satisfactory definitions under good transmission and reception conditions. However the overall tolerances for achieving these conditions are different for the various systems. Each system has advantages and disadvantages and no one system has an overriding advantage which enables easy selection.

NTSC is claimed to be the cheapest of the three systems and this coupled with the fact that the NTSC has been operating for ten years are important advantages. However, NTSC has a number of basic disadvantages: colour distortion due to phase shift; cross talk between simultaneously transmitted colours and differential phase shift where one colour is distorted more than another caused by cumulative non linearities in the transmitter receiver chain including microwave relay links. This can be particularly disturbing under conditions of multipath reception. Another problem is single sideband distortion, particularly on the low frequency TV channels, which causes colours to appear topsided. A disadvantage of NTSC that was discussed at length is that NTSC receivers need four independent controls — brightness, contrast, hue and saturation — which require too many adjustments of too many knobs to assure the right combination.

SECAM (sequential and memory) was conceived by Henri de France of the Compagnie Generale de Television for the express purposes of eliminating the disadvantages inherent in the NTSC system. In this system only one colour signal is transmitted at a time and the transmitted colour signal alternates from line to line. Since both colour signals must be available simultaneously at the receiver a memory device (delay line) stores each transmitted line so that it is available as the missing signal for the next line. In effect this halves the vertical colour resolution but as this is still considerably more than the horizontal resolution the difference cannot be noticed.

Because only one colour signal is transmitted at any one time SECAM is able to use frequency modulation and the colour signal is therefore not sensitive to phase or amplitude distortion. The SECAM signal is so stable that there is no need for hue or saturation controls on the receiver and has the major advantage that there are no problems in videotape recording or transmission over long relay links. In television studio operation however this system has one disadvantage in that when mixing, fading and switching in the studio each colour signal, red, blue, green must be treated individually and not as a composite signal as with NTSC. Studios therefore must have three perfectly matched colour channels rather than one channel to handle colour transmission with consequent added expense.

PAL was developed by Walter Bruch of Telefunken. This system has the advantages of both NTSC and SECAM and in fact is NTSC using an error correcting mechanism of phase alteration to automatically cancel differential phase errors and single sideband distortion.

Continued on page 22

Medium and High Frequency Band Aerial with Vertical Directivity

An aerial suitable for short range sky wave communication circuits, which presents an almost uniform impedance over a 20:1 frequency range, is described. Some notes on the technique of fabrication are given.

by A. C. Stanbury, M.Sc.,
Geophysical Observatory
D.S.I.R., Christchurch

Introduction

The application of broad-band RF power amplifiers to communication systems has created a demand for aerials having a radiation pattern and an impedance characteristic which does not change with frequency over the MF and HF communication bands. The long-periodic aerial (G. A. Deschamps and R. H. Du Hamel 1961) can be designed to cover a very wide frequency range with uniform directional and impedance characteristics but the complexity of the radiating system, and the large linear dimensions for MF operation, make this system expensive and cumbersome. Although this aerial is remarkably efficient within the designed frequency range, performance falls off rapidly outside these limits and no compromise design is possible.

The discone aerial, and derivations of it, will operate throughout the HF band giving an omnidirectional low angle radiation pattern (H. P. Westman 1959, Collins Radio Company 1959). Short range sky wave communication requires another form of aerial with vertical directivity.

The Geophysical Observatory of the Geophysics Division, D.S.I.R. has made extensive use of a multiple wire delta aerial described by Cones, Cottony, Watts, 1950, in application to ionospheric soundings over the frequency range 1.0-22.0 Mc/s. This aerial radiates maximum power in the vertical direction and has an essentially resistive impedance over the entire frequency range. These characteristics, combined with ease of fabrication, small size and low cost, make this aerial very attractive for communication circuits.

The Multiple Wire Delta Aerial

A schematic presentation of the aerial, with dimensions appropriate to a low-frequency limit of 1 Mc/s is shown in Fig. 1. The originators of this design consider it to be a variation of an inverted V with the input applied to the extremities of the V through horizontal wires, thus forming the delta shape from which its name is derived. The multiple wire construction lowers the impedance of the aerial and enables impedance variations to be minimised by varying the spacing of wires that compose the individual elements.

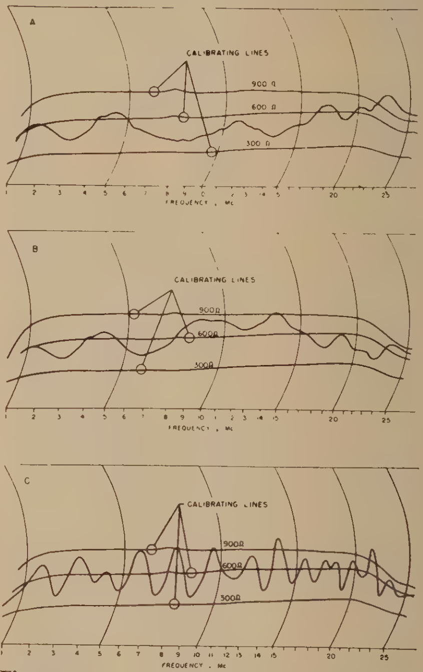

Figure two

The dimensions given in Fig. 1 can be scaled for higher minimum frequencies, and although ideally all elements of the radiating system should be scaled by the same factor, it has been found that the following dimensions can be held constant. (1) 6' ground clearance, (2) 1' spacing of wires in horizontal elements, (3) 3' tapering ends of horizontal ele-

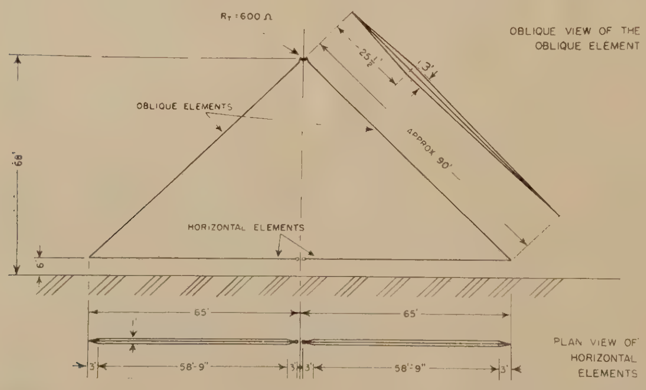

Figure one

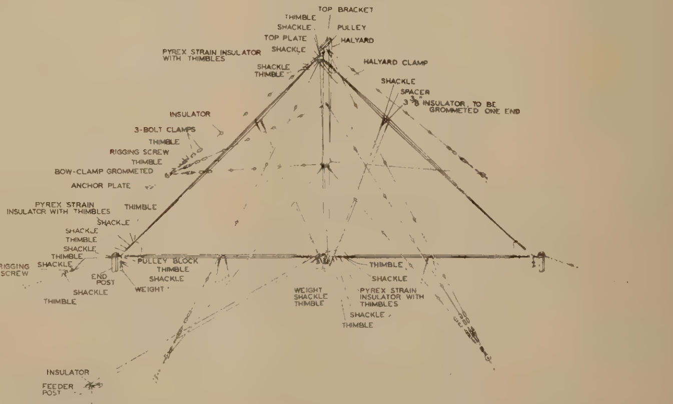

Figure four

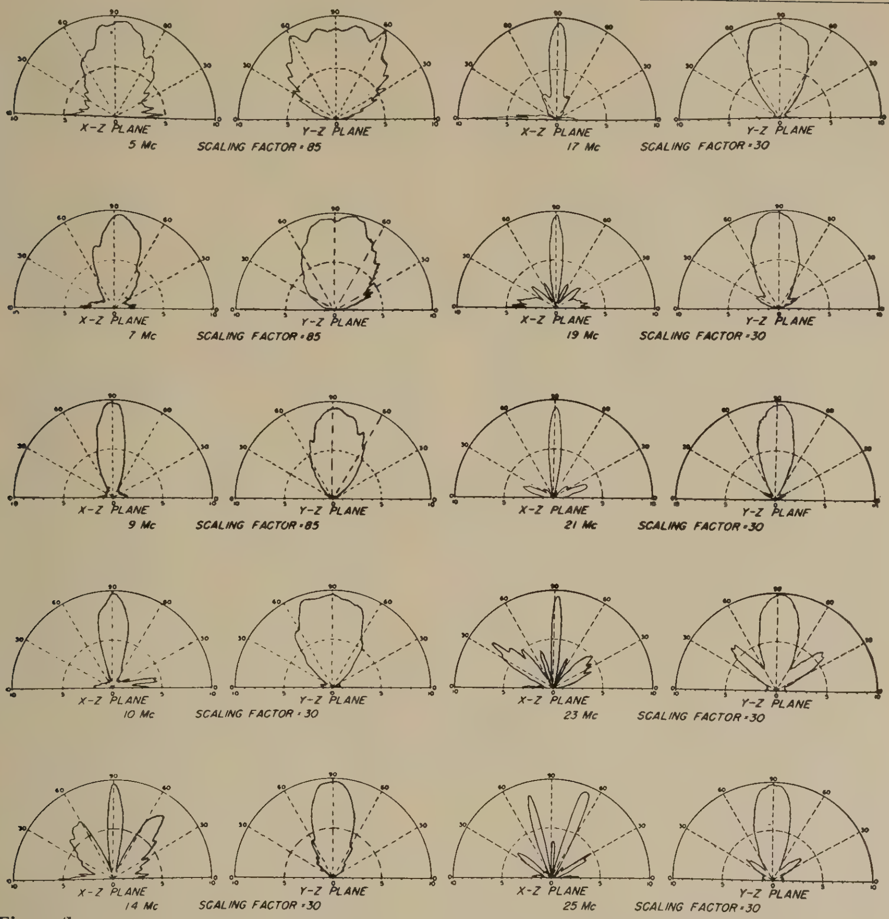

Figure three

ments, (4) maximum spacing of wires in oblique elements. Table 1 lists the length of the major elements for a range of sizes giving satisfactory impedance characteristics from the indicated frequency to over 20 Mc/s.

TABLE I

Lowest Frequency	Horizontal Element	Oblique Element top to 3' spacer	Oblique Element 3' spacer to end	Mast Height
1 Mc/s	65'	25½'	64½'	68'
2 Mc/s	32½'	13'	32'	37'
3 Mc/s	22'	8½'	21½'	27'
4 Mc/s	16'	6½'	16'	21½'
5 Mc/s	13'	5'	13'	18½'

It has been found that the efficiency of these aerials rises appreciably as the working frequency is increased to twice the minimum frequency stated. In a communication system requiring efficient radiation it is therefore desirable to double the figures given in the 'Lowest Frequency' column.

Electrical Characteristics

Figs. 2 and 3 showing impedance measurements and radiation patterns are reproduced from the original paper (Cones, Cottony, Watts, 1950). The impedance curves of Fig. 2 apply to an aerial of the dimensions given in Fig. 1. Vertical polar diagrams obtained from scaled models, using the scaling factors indicated, are shown in Fig. 3. The X-Z plane coincides with the plane of the aerial and the Y-Z plane is at 90° to this direction.

Figure five

Measurements of impedance made by the Geophysical Observatory are in general agreement with Fig. 2 and additionally it is found that the reactive component of the impedance tends to increase with frequency but is always less than ± 20 pf.

Independent tests made on a scaled aerial using a commerical I KW broadband amplifier failed to give a readable deflection on the reflectometer incorporated in the unit anywhere within the range 2.0-24 Mc/s (D. M. Suter, Private Communication).

Notes on Fabrication

A pictorial diagram of a typical installation using an oval section tubular-steel mast is shown in Fig. 4. It is desirable to insulate all guy wires in sections which are small compared with half a wave-length at the highest operating frequency.

Each span of three spaced wires must be stabilised against rotation during high winds by means of drop wires as illustrated, or, in the case of the horizontal elements, with additional supporting posts. The wires are held apart by spacers of thin walled copper tubing drilled to take the aerial wire and fastened in place with soft copper wire bound and soldered to the aerial. The three wires of each span must be under

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equal tension if the span is to lie stably in a horizontal position and this is obtained with a minimum of equipment by the following procedure:—

Cut three wires about ten feet longer than the desired span and make off one end around a thimble leaving three feet of free end for interconnections. All three conductors must be bound together with soft copper wire soldered in place. Fig. 5 shows the form of the binding: this illustrative example has not been soldered. Attach the thimble to a solid support 3' to 5' above ground level. Thread copper tubing spacers on from other end and locate them close to the final position.

Attach the three free ends to separate turnbuckles tied to a solid support a few feet above ground level applying sufficient tension to keep wires clear of the ground. Hold all three wires loosely together with a wire rope clamp at the point where the binding is to start when making off around the thimble at this end of the span. The two outer wires should be tensioned so they hang roughly level and the spacers positioned correctly by sliding them along the aerial. Place a spirit level across the middle of the span so it is supported by the two outside wires and adjust the tension with the turnbuckles to make these two wires level. Check that the spacers and wire clamp have not moved.

Remove the spirit level and tighten the middle wire until all three wires are level when sighted across the middle of the span. Bind the three wires together at the wire rope clamp and solder. Bind and solder on each side of the copper spacers on all three wires. The ends can then be freed from the turnbuckles and made off around a thimble continuing the binding started earlier near the wire rope clamp. Fig. 5. If required the completed span can be rolled on a drum for moving.

The pictorial diagram shows the short cross arm on top of the mast which gives clearance for the terminating resistor mount. The halyard is taken across the top of the mast through pulley blocks at each end of this member to give symmetrical loading on the mast. The terminating resistor must be capable of dissipating one half the total power supplied to the aerial.

The author is indebted to the United States National Bureau of Standards for permission to reproduce Figures, 1, 2 and 3, and to the University of Canterbury Industrial Development Department for Fig. 4. Assistance given by Mr. M. M. Gill, of the Geophysical Observatory, in preparation of all figures is acknowledged.

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CCIR STUDY GROUP MEETINGS

—continued from page 19

By reversing the phase of the subcarrier in the I modulation at the transmitter and receiver every alternate line phase error and cross talk components in one line are reversed in phase on the next line and therefore cancel out at the receiver after a two line period.

Simple PAL receivers are exactly the same as NTSC receivers except for the addition of the switch for reversing the I demodulator axis every line. Such receivers are inexpensive and simple compared with SECAM receivers and provide excellent colour pictures as long as the phase error does not exceed 25°. (With NTSC a phase error of only 10° is noticeable). When the phase error exceeds 25° it is possible to see differences in colour from line to line. This can be tuned out by adjusting the reference phase of the local sub carrier by means of a control corresponding to the hue control on an NTSC receiver.

In Deluxe PAL receivers, phase errors are cancelled by means of a delay line similar to that used in SECAM, thus eliminating the need for a phase control. Although the addition of a delay line might add say £5 to £10 to the retail price of the receiver, this additional refinement could be of considerable advantage in fringe areas.

In television studio operation NTSC and PAL both allow the use of the composite signal for switching and special effects. Both require the use of special colour video tape recorders. A PAL signal however is much easier to handle because differential phase requirements and time-base stability requirements are much less stringent than with NTSC. For these reasons many broadcasting organisations are contemplating using PAL within their TV studios, decoding at the transmitter and re-encoding the signal into whatever system it is decided to use for transmission to the public.

The decoding and encoding can be done without loss of quality and it is considered that this would be good practice even if the PAL system was adopted for transmission. This would mean that an error free signal was transmitted and that the receiver would only have to correct for phase shift and differential phase distortion caused by the topography of the transmission path.

These matters were fully discussed at Vienna accompanied by excellent demonstrations of the competing systems. Although no one system received unanimous support all delegates to the Study Group meeting left convinced that efforts to secure a single system must continue and the subject will be examined again at the XIth Plenary Assembly in Oslo in 1966. The choice of colour for the 625 line/50 field system appears to lie between SECAM and PAL and it is of interest to note that the BBC are now conducting field tests of the PAL system.

SERVICEMAN'S COLUMN

by J. Whitley Stokes

Just recently I received from one of Auckland's largest service companies an interesting brochure dealing with 'trade service'; by this is meant a repair service established and maintained for the benefit of dealers. There is nothing new in this, of course, in that trade service has always been available in the form of factory or distributor operated service departments.

What is new is that in the case of the above mentioned organisation, the facilities offered go far beyond the previously accepted limits of trade service. For example dealers are offered a free collection and delivery service either to and from the dealer's business premises or (note this) the dealer's customer's home.

This feature does not just cover bulky articles difficult of transportation e.g. TV receivers and radiograms, but also includes such small pocketable items as electric shavers. Whether this newly introduced service heralds a trend remains to be seen but it seems likely that the easier any such service becomes available the more likely it will be made use of by dealers.

Particularly will this be true in the case of an item requiring guarantee service or a new item received in a defective condition or an unsold item which has developed a fault whilst still in stock. In the past it has often been quicker or more convenient for the dealer's own service department to carry out repairs on such items rather than return them to the distributor.

A widespread increase in the number of such distributor or factory operated service organizations could do much to change the existing set up whereby the responsibility for after sales service has traditionally been on the dealer's shoulders. Of course it goes without saying that any such pattern of events will of necessity be confined to the metropolitan areas — the country dealer, cum or sans service department, will be unaffected.

The trend towards large centralised service depots came simultaneously with the introduction of television where an almost overnight need for the large scale erection of outside aerials could not have been adequately met in any other way. This need then, coupled with the introduction of the so called 'service contract' has meant that the bulk of TV servicing has always been in the hands of a few large companies.

Another factor causing this situation is the changing pattern in retail trading whereby the bulk of 'consumer durables' is now sold by home appliance stores which are purely retail concerns not having any service facilities of their own.

Does this trend in the pattern of servicing indicate the shape of things to come? It is always a risky thing to make prophecies as the prophet is so often proved wrong by a subsequent turn of events, but if I were asked for my opinion it would be as follows. Taking the case of TV receivers, which undoubtedly account for the majority of all servicing, there is every indication that the bulk of initial servicing will continue to be handled by service companies. By initial it is meant the period during the first two or three years of the receiver's life. After that depending both on the owner's experience during the period and the availability of a localised suburban service the owner may elect to do one of three things.

1. Carry on with an annual service contract.
2. Obtain chargeable service as required.
3. Change to a local serviceman or small suburban firm employing one or two servicemen.

In the days before the advent of TV, several firms had tried and failed to 'make a go' of radio servicing on a large scale basis, in one case a nation wide basis. Whether or not TV servicing can be handled successfully on a similar basis and over a long period of time remains to be seen, as does the possibility that centralized servicing will eventually take the place of scattered individual servicemen or small suburban firms. Time will tell, but I have a feeling that the neighbourhood serviceman will be around for a long time yet.

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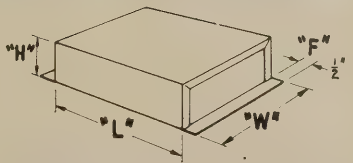

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LISTENING POST

by michael lawrence

All times are in GMT and frequencies in kilocycles

The frequency schedules now being used by most shortwave broadcasting organisations should remain much the same until early March 1966. This schedule period, laid down by the International Frequency Registration Board, started on the 7th November and is designed for summer reception conditions.

AUSTRALIA. Radio Australia are now transmitting a special sporting service to N.Z. on Saturdays from 0230 - 0900 on 15330. This service was previously transmitted only on 21540 to South East Asia and on the domestic shortwave frequency of 15230 and reception of these channels was generally poor.

CEYLON. The Commercial Service of Radio Ceylon broadcasts an English language programme to Asia from 0130 on 9667 and 15230 and again from 1300 - 1645 on 9667. Reception on 15230 is marred by the A.B.C. on the same frequency.

CHINA. Radio Peking can be heard with very strong signals when it broadcasts two English programmes to Australia and N.Z. from 0830 - 0930 and 0930 - 1030 on 15080 and 15435. The latter frequency has been used for several years by the BBC for their N.Z. transmission from 0900 - 1130 but, since the occupation of this channel by Radio Peking early in November, the BBC has become unusable until after 1030.

MONACO. Trans World Radio in Monte Carlo provides good reception when it transmits in English to the British Isles from 0730 - 0840 on 7260.

PORTUGAL. 7225 and 9645 are the two frequencies used by the Voice of the West in Lisbon for the English language transmission to Australia and N.Z. from 0730 - 0815 and to the Far East from 0815 - 0900. The 7225 kc/s frequency is announced incorrectly by the station as being 7130. The BBC on 9640 causes considerable interference to the 9645 outlet until 0845.

SOLOMON ISLANDS. The Solomon Islands Broadcasting Service at Honiara is on the air in English from 0730 - 1130 on weekdays, 0800 - 1130 on Saturdays and 0830 - 1120 on Sundays. Transmitters used are VQO on 1030 (660 watts), VQO3 on 3205 (500 watts) and VQO4 on 3995 (5000 watts). Local news is broadcast at 0745 and 0930 on weekdays.

A letter from the Broadcasting Officer at this station says that a new vertical incidence aerial is at present being erected in order to improve reception within a radius of 250 miles and this may have an adverse effect on long distance propagation. The new aerial is expected to be in use early in 1966.

EGYPT. Dictation news in English is broadcast by the United Arab Republic Broadcasting Corporation from 0630 - 0700 on 7075 and 9475.

U.S.S.R. The first English transmission to Great Britain and Ireland is broadcast by Radio Moscow from 0700 - 0730 on 9740, 9480, 7280, 7240 and 5980. The 7240 channel appears to provide best reception in N.Z.

The second transmission to Great Britain is from 1200 - 1230 and can be heard on 11745.

SWITZERLAND. The complete English language schedule of the Swiss Broadcasting Corporation is as follows:—

To Japan and Korea: 0700 - 0800 on 9670 and 11865; To Australia and N.Z.: 0845 - 0945 on 11865, 15305, 17820, 21520; To U.K. and Ireland: 1145 - 1245 on 9665 and 11865; To India & Pakistan: 1330 - 1430 on 11865 and 15305; To Africa: 1330 - 1430 on 17845 and 21520; To the Near and Middle East: 1515 - 1615 on 9655, 9665 and 11865; To North America: 1515 - 1615 on 11715; To Africa (weekdays): 1900 - 2000 on 9595 and 11810; To Africa (Sundays): 1830 - 2000 on 15305; To East North America: 0115 - 0215 on 6080, 6120 and 9535; To West North America: 0415 - 0615 on 6120.

NEW ZEALAND. Several changes have occurred in the schedule of Radio New Zealand which is now as follows:—

To Pacific Islands: 1700 - 1945 on 9540 and 11780; 2000 - 0545 on 15280; 0600 - 0845 on 9540 and 11780.

To Australia: 2000 - 2230 on 11780; 2245 - 0545 on 15110; 0900 - 1145 on 9540 and 11780.

To Antarctica: (Sundays only) 0815 - 0845 on 9540.

U.S.A. Radio New York Worldwide operates on the following schedule: —

To Europe: 1200 - 1355 on 15155; 1400 - 2045 on 15440; 2100 - 2400 on 9740; 1200 - 1845 on 17845; 1900 - 2145 on 11970.

To Africa: 1500 - 1945 on 17845; 2000 - 2145 on 11880; 1200 - 1500 on 17845 (weekends only).

To Latin America: 1200 - 1355 on 15155; 1400 - 2130 on 15440; 2145 - 2400 on 11905; 1200 - 1445 on 15385 (weekends only); 1500 - 2145 on 17730.

The programme "DXing Worldwide" is broadcast every Saturday at 1330 and 2130.

The complete schedule for the Armed Forces Radio and Television Service is:—West Coat Transmitters:

2130 - 0300 on 17765 2130 - 0400 on 15410; 2300 - 0200 on 11790; 0230 - 1400 on 9760; 0300 - 0700 on 11895; 0315 -1630 on 9700; 0700 - 1630 on 5965; 0700 - 1030 on 15210. (Philippines relay).

East Coast Transmitters: 1330 - 2245 on 15330 and 15430; 1900 - 2245 on 11790.

ETHIOPIA. ETLF, The Voice of the Gospel, has been reported on 11875 with a transmission in English to West Africa from 0500 - 0530 on Tuesdays, Wednesdays and Thursdays.

GHANA. Radio Ghana broadcasts in English from 1500 on 17910.

WINDWARD ISLANDS. The Windward Islands Broadcasting Service has been heard to sign off 11795 at 2200.

GERMANY. The English transmissions to N.Z. from Deutsche Welle are 0845 - 0940 on 17845, 15275 and 11925; 2110 - 2200 on 7175 and 5980.

Continued on page 29

THIN FILM CIRCUITS

by Peter L. Watts *

Introduction

The article entitled 'Microelectronics' by W. J. Baker in the November 1964 issue of "Radio Electronics and Communications" has provided incentive for a more detailed look at the designs and applications of thin film circuits. Furthermore, emphasis normally seems to be given to integrated semiconductor circuits without realisation of the capabilities and similarities of thin film circuits.

Originally, the term Microminiaturisation was given to embody any of the three basic methods which could drastically reduce the size of an electronic circuit:

1. Miniature components in wafer or cordwood arrangements.
2. Integrated semiconductor circuits.
3. Thin film circuits.

The first method came into being more than twenty years ago when military equipment was produced by assembling stacks of bakelite wafers (approximately one inch square) in a column, with each wafer holding perhaps three or four passive components. Often on the top of such an assembly, an octal socket would be utilised to hold a pentode or double triode. This method, now more commonly known as the cordwood method, developed rapidly and before long the extensive use of printed circuits became commonplace.

With the advent of transistors and miniaturised components extremely compact units have become possible. This technique has been refined to such an extent that discrete components are even inserted in cavities cut out of the printed circuit board in a method referred to as the dot, pellet, or Swiss cheese methods. Nevertheless, this does suffer from problems of reliability in jointing and would appear to have its limitations.

The latter two methods are both classified under the 'Microelectronics' heading (distinct from Microminiaturisation) and provide the basic means of producing microelectronic circuits. The previously mentioned article describes the general development and history of Microelectronics and makes brief references to the form of thin film circuits. It does however emphasize much more the importance of integrated semiconductors. The article discusses the advantages of silicon semiconductors as active devices and also the deficiencies of silicon (and other semiconductor material) as passive devices. It follows on to describe the multichip approach which allows different components of their different composition to be deposited on a non-active substrate. A brief description follows, regarding the development of hybrid circuits which enable a combination of integrated semiconductor and thin film devices.

At present, there are several variations to the multichip approach and of these the monolithic approach seems to have gathered a large following. This method includes the use of semiconductor resistors and capacitors which can be diffused onto the monolithic silicon substrate along with active 'diodes' and 'transistors'. Although tolerances and parasitics form the major drawbacks in the monolithic approach, digital or logic circuits compare reasonably with those constructed by the hybrid method, while linear circuits prove superiority in applications such as D.C. amplifiers since the common structure ensures linearity over a wide range of temperatures and environment.

Thus, we have two predominant systems of 'Microelectronics' at present;

1. the Hybrid approach which utilizes thin film passive components, and
2. the Monolithic approach utilizing semiconductor devices as active and passive devices.

Nevertheless, efforts are presently being made to produce thin film active components and already such devices as Diodes,

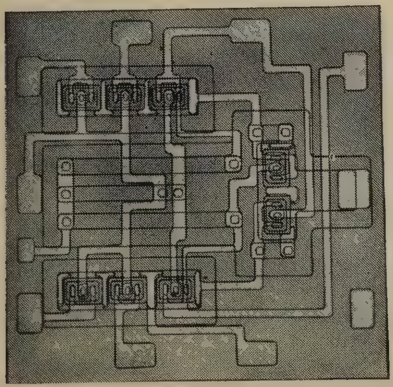

Fig. 1. Motorola Type MC352, 1302. Flip-Flop Integrated Circuit using the monolithic silicon epitaxial passivated technique.

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* W. & K. McLean Ltd.

Tunnel Triodes, Field-Effect Triodes and Thin Film Transistors are undergoing test. This could well change the whole idea of microelectronics and the general background to thin films would assume much greater importance. In addition even the hybrid approach most certainly warrants full understanding of the thin film technology.

Thin films

Thin film technology was initiated during the war years when deposition of metallic materials on glass or ceramic were studied for use as resistive proximity fuses. The accuracies obtainable were soon realised and subsequent development has produced passive components of excellent values, tolerances and stabilities in exceedingly small physical space.

Fabrication Techniques

Generally, the requirement for thin film manufacture is the deposition of metallic or semiconductor material on non-active, (passive) or insulating substrate.

In the vacuum deposition technique the atoms of the metallic or semiconductor vapour strike the surface of the substrate which is maintained at a much lower temperature than that of the evaporating source. Upon striking, the majority of the atoms will be absorbed by and adhere to the substrate whilst a few will either be absorbed and re-evaporated again or actually bounce off the substrate surface. Since the absorbed atoms will lose their kinetic energy the combination of substrate and thin film will rise in temperature so that theoretically further re-evapouration should not occur. There is of course an interacting energy between the absorbed atoms. However this nucleation effect is normally reduced by the selection of deposited material.

Selective depositions are made by means of mechanical masks which are placed on the substrate before evaporation is commenced.

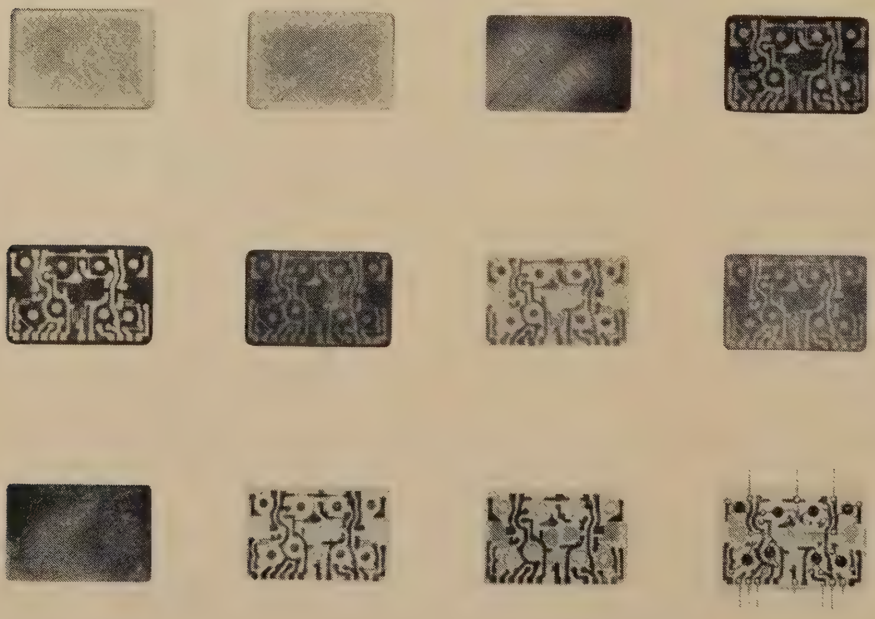
A further recent method is to cover the entire insulating substrate with the resistive material by the usual vacuum/vapour deposition technique, then cover the entire surface with a conductive material such as copper. The assembly is then chemically etched using photographic techniques of masking. Photographic masks can be simply reduced in size by standard procedures commonly applied to printed circuitry.

Another, well known method is "cathodic sputtering" which involves creating a low pressure glow discharge in an inert gas atmosphere and grounded anode. A high negative voltage at the cathode, constructed of say tantalum, produces ionized molecules of tantalum which bombard a substrate placed between the cathode and anode. Although both the vacuum evapouration and this method require high vacuums, the latter operates at reasonably low temperatures which reduce the possibility of contamination from the evaporating source.

Characteristics

One of the early approaches to thin film circuitry was through the use of discrete semiconductor elements in conventional form. Here the leads from say a transistor would be soldered to the corresponding pads on the deposited film circuits. Subsequently, unencapsulated semiconductor active elements would be mounted on the substrate in chip, pellet or dot form and connections to the thin film circuit vacuum deposited in the usual manner using conductive material. This is the basis of hybrid circuitry which will be discussed in more detail later.

Fundamentally, the use of thin films applies at present to the manufacture of resistors, capaci-



FROM LEFT:
Top: Glass moulding; polished substrate; coated with copper; developed photoresist.
Centre: Etched and copper resistor mask; coated with nichrome; resistor pattern; photoresist mask.
Bottom: Coated with gold; conductor pattern, capacitors deposited; transistors and diodes added.

Fig. 2. Photographs of a microcircuit in various stages of manufacture. The active devices (transistors and diodes) are conventional miniaturised components, and are assembled in the 'Swiss-cheese,' 'pellet,' or 'dot' methods. (Courtesy of Mullard Ltd.).

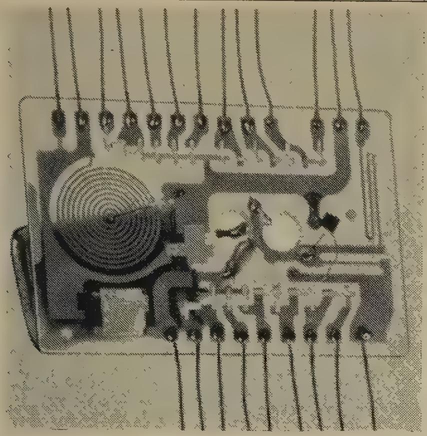


Fig. 3. Microcircuit of a 50 Mc/s crystal controlled oscillator showing a 0.7 μH deposited inductor on the left hand side.

tors and inductors and following provides a review of their general physical and electrical characteristics.

Resistive Thin Films

For quite some time, resistor manufacturers have been able to produce tin-oxide film resistors by methods of hydrolysis and at present this method obtains resistivity better than 5000 Ω/square. Actual resistance values of 1KΩ to 10MΩ with tolerances of ±10% and temperature coefficients of + 300 ppm/°C and with power ratings up to $\frac{1}{4}$ watt.

More recently several metals and alloys have been deposited on passive substrates to form high accuracy thin and thick film resistors. Among these are aluminium, titanium and tantalum and the film can be trimmed to the desired value by anodizing its outer surface. This effectively forms an oxide, the thickness of which is proportional to the anodizing voltage, thus the oxide growth can be controlled very accurately. Of these metals tantalum and titanium have been used to achieve resitivities of 500 Ω/square and 2000 Ω/square repectively, with relevant temperature coefficients of ± 200 ppm/°C and —100 ppm/°C. Alloys of nickle-chromium, nickle-titanium, and platinum-gold have also shown excellent results.

Generally, the substrate is a passive one made of glass or a ceramic and this same substrate may also be used to deposit capacitors, conductors, and inductors.

Capacitive Thin-films

Development of these has been recent, and the basic principle is that a dielectric is deposited between two conducting metallic layers by standard vacuum techniques.

Thus, conducting metals such as tin, magnesium, silver, and gold are used to form the electrodes, and the initial layer is deposited on the substrate. Metals of high conductivity such as gold have the advantage that adhesion to the substrate is more efficient and they are less prone to oxidation. The dielectric is then deposited on the conductor and with silicon-monoxide dielectrics capacitance values of 0.002 to 0.01 μf/cm^2 can be obtained. Breakdown voltages are high depending on the thickness of the dielectric. Finally, a further layer of conducting metal is deposited to form the counter electrode of the complete capacitor.

Other oxidized metals can actually be used as dielectrics, for example aluminium, titanium and tantalum. The metal is deposited on the substrate and then oxidised by anodizing. The oxide thus formed acts as the dielectric and a final conducting material is deposited to provide the counter electrode. Higher capacitive values are possible using this technique. However it is at the expense of the working voltage.

An interesting development has been in the hybrid approach to formation of microelectronic capacitors wherein an oxide dielectric is grown on a semiconductor substrate. The semiconductor material forms one electrode of the capacitor and the counter electrode of a conducting metal is deposited on the oxide by standard thin film techniques.

Inductive Thin-films

Some work has been done in this field with varying degrees of success. Whilst thin-film inductors are practically possible there are some severe limitations in regard to R.F. and shielded applications.

Generally, inductors are formed by depositing a spiral conductor of say nickel-iron or ferrite on the substrate. The nickle-iron inductors have been used as storage devices in logical matrices and as low frequency inductors for low inductances. In the former case it is necessary to provide a magnetic field to enable magnetic anisotropy of the film. This takes the form of a square-loop B-H curve thus providing bistable conditions. The normal magnetic orientation during deposition provides a more linear B-H curve suitable for the latter application as an inductor.

Deposition of ferrites, on the other hand prove of greater interest since inductors of manganese-zinc ferrites have enabled frequencies up to 500 Kc/s. Higher frequencies still (up to 100 Mc/s) have been attained using nickel-zinc ferrites. The ferrite compounds do not require an orienting magnetic field during deposition since they do not have the same magnetic ansiotropy as nickle iron films.

Conclusion.

It can be seen from the above that many interesting developments have come about in thin-film microelectronics. The most pertinent factor at present seems to be in relative costs. Thin-film circuits survival, depends on whether or not the state of the art of monolithic development can produce reliable and precision passive components or if outstanding advances are made in the production of thin-film active devices.

ENQUIRY CARD AD. 15

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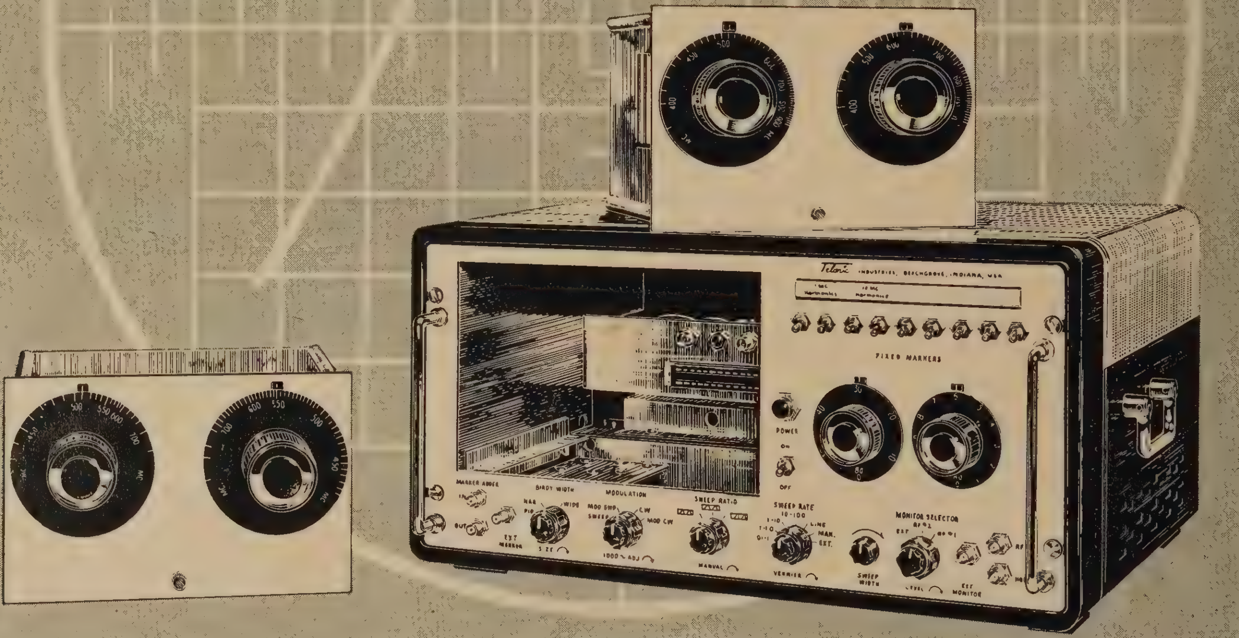

As a major designer and manufacturer of RF instruments and components, Telonic once again leads the field with the introduction of the SM-2000 Sweep and CW Signal Generator. New from every standpoint, the SM-2000 provides unmatched versatility for laboratory or production operations. Now, with one instrument and several, interchangeable plug-in oscillators, an engineer can cover a frequency range from audio to 3000 mc.

Telonic has designed 19 different oscillator heads for specific and general purposes that enable the user to change range of the SM-2000 in a matter of seconds. For general applications, only two plug-in units are necessary to cover frequencies from .5 to 2000 mc. And, in addition, the operator may select four different functional modes with the SM-2000—swept RF, modulated swept RF, CW, and modulated CW. He can set attenuation from 0 to 60 db in 1 db steps with the two built-in attenuators. He also has provisions in the instrument for use of an external marker, or for adding up to eight fixed, plug-in markers if desired.

All these features are combined with the fine basic performance that has made the name Telonic synonymous with the best in RF instrumentation—low VSWR, high display linearity and excellent workmanship. If you would like more complete details on this new sweep generator please write for Technical Bulletin T-233.

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TRACKING GEMINI SPACECRAFT

IN WESTERN AUSTRALIA

At Carnarvon (Western Australia) tracking station, more than 100 men and women employed by Amalgamated Wireless (Australasia) Ltd. were engaged on a round-the-clock operation during the recent tracking of the Gemini spacecraft. AWA operates and maintains the station for the Australian Department of Supply. The staff includes engineers, technicians, teleprinter operators, "trials" assistants, stenographers and clerical workers. Technical and administrative staff were recruited by AWA from the ranks of its own employees, from every Australian State and some were brought from the U.K.

In the Gemini tracking project, the staff operated a wide range of the most modern, highly specialised equipment. This included the FPQ-6 radar, one of the most accurate high-power tracking radars developed to date. This long range (32,000 miles) radar provides the accuracy required in space research with respect to azimuth and elevation angles. Its parabolic antenna is 29 ft. in diameter. The equipment is housed in a two-storey concrete building and the antenna is mounted on a separate tower adjacent to the building. A team of seven engineers and technicians are needed to operate and maintain this substantially transistorised equipment. Angle and range data can be transmitted over teletype links in real time to appropriate computers in the United States.

Because the Gemini programme required two spacecraft to be tracked simultaneously, there are two separate Acquisition Aid systems. Each system locks-on to the spacecraft's radio signal and as soon as the antenna positions itself on the spacecraft, the operator at the acquisition console distributes the azimuth and elevation angles to equipments such as the precision tracking radar FPQ-6. A central accurate timing system ensured that all electric clocks and timing pulses were kept within five milli-seconds of the standard time in use by the world network. Various measurements taken in the spacecraft or by its external monitoring equipment were relayed to earth in such a way that the earth station had an exact replica of such measurements. These included the astronaut's respiration rate, heartbeat and blood pressure, as well as measurements of scientific data, such as temperatures and fuel levels.

When received by the acquisition aid antenna, the signal was passed on to the telemetry receivers. The original intelligence was sent to the control centre for visual display and was converted by a computer to teletype data and sent to the main control centre in the United States for record purposes. This information is time tagged and stored on magnetic tape for later analysis.

Those operating the Command System were able to send instructions to the spacecraft. These originate in the main from station flight-controllers sent by N.A.S.A. from U.S.A. to Carnarvon whenever a manned space flight is in progress. The instructions may be used to initiate actions or change functions such as transmitting calibration signals in lieu of the normal telemetry signals. The Carnarvon station is connected permanently by voice and teletype circuits via suitable landlines and COMPAC with U.S.A. The teletype system carries data provided by the various equipment about or from the spacecraft as well as its exact position as it passes over the station. The voice circuit is used in a similar manner and ensures effective control from the American control centre over all tracking stations in the Network associated with the mission. The connection between Carnarvon and Geraldton is supplemented by a Troposcatter link as cyclonic disturbances have on occasions caused breakdowns in the existing landlines. This Troposcatter link, the first in the Southern Hemisphere, beams its radio waves into the troposphere where it is reflected and picked up by receivers some 300 miles away. Both terminals possess transmitters and receivers to allow two-way communication.

BROADCASTING FROM A TRAIN

A complete local broadcasting station, including two studios and control room, has been fitted into one of the 13 carriages drawn by the "Radio Show Special" train now touring Britain to show the products of a major British radio and television manufacturing group.

For late night shows the disc jockey on the train is also studio engineer and conducts the entire station's output from the control room which can double as a third studio as shown. Before him is the simple control panel which allows mixing from eight different sources. To his right are twin record turntables and to his left, a tape recorder. The size of transmitter to cover a town with an acceptable broadcasting signal over a ten mile radius range can be housed in a cabinet measuring 6 x 2 x 2 ft.

Complete equipment for a local broadcasting station serving a town with a population ranging from 50,000 to 100,000 would cost approximately £10,000 sterling. Am ambitious station might cost more, while a modest initial set-up could cost less. To this figure must be added the cost of the studio, equipment room and office.

ENQUIRY 243

SHORTWAVE SURVEY

Continued from page 24

PAKISTAN. Radio Pakistan can be heard in English at 0830 on 21590 and 17760, and at 1500 on 9820.

DENMARK. After months of suffering severe interference the Voice of Denmark is again becoming audible in the transmission to N.Z. from 0900 - 1000 on Tuesdays, Thursdays and Saturdays on the frequency of 15165.

PIRATE STATIONS. An item from Radio New York Worldwide says that while being unloaded for the pirate station, Radio City, at a fort in the Thames Estuary, a £2,200 transmitter fell into 40 feet of water and was lost.

ENQUIRY CARD AD. 7

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Model 8 Mk III universal AvoMeter

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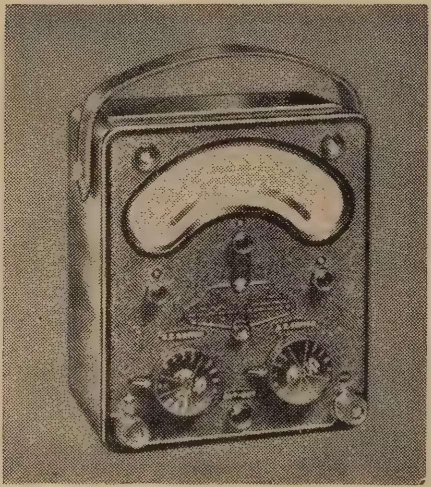
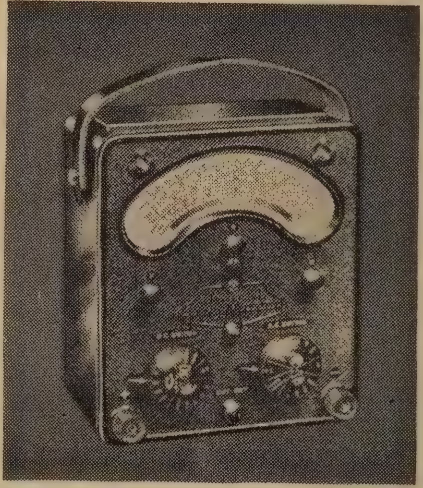


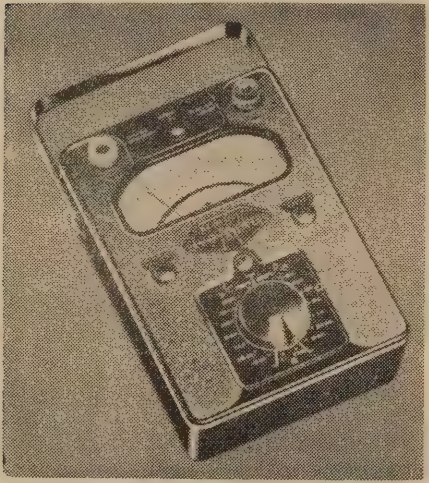
Model 7 universal AvoMeter

This 50 range ac./d.c. moving coil instrument is fitted with a 5 inch hand calibrated scale, incorporating an anti-parallax mirror. Its accuracy enables it to be used for measuring audio-frequencies



Model 40 universal AvoMeter

A 40-range a.c./d.c. moving coil instrument designed around a 3mA d.c. movement for the heavy electrical engineer. An automatic overload cut-out device is incorporated to safeguard the instrument against misuse



Heavy Duty AvoMeter Mk V

An 18 range instrument specially designed for use under difficult conditions, such as outdoors, where a portable instrument of strong construction is needed. Sensitivity: d.c. 1,000 ohms per volt: a.c. 500 ohms per volt, except on the 10V a.c. range, which is 200 ohms per volt.

Model 9 Mk II AvoMeter

Recommended for Television engineers, this multimeter is essentially the same as the popular Model 8 Mk III, but differs in the following points . . . both the a.c. and the d.c. voltage ranges go up to 3000V. All ranges are identified with graphical symbols, which follow the I.E.C. (International Electrical Committee) recommendation.

The Multiminor Mk IV

A well made simple to use pocket size instrument. Ranges: a.c. voltage 10 to 1,000 volts: d.c. voltage 100mV to 1,000 volts: d.c. current 100uA to 1A.

There is also a full range of AVO Precision and Test Instruments.

A I.5

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BOOK REVIEWS

This month we present reviews of three books received by courtesy of their respective publishers, dealing with the topic Microminiaturization.

"Introduction to Integrated Semiconductor Circuits" by Adi J. Khambata of the Sperry Rand Corporation, and published by John Wiley and Sons, Inc., New York. — This 219 page book serves as an excellent introduction to the subject of integrated semiconductors and seems to be aimed at providing a condensed review of theory, techniques, and applications for electronic engineers. Although the author has personally carried out notable work in this field, the book is not particularly outstanding from the physics and design point of view. Moreover, it successfully collects and collates various material from a wide variety of sources. Many other publications available deal specifically with individual topics.

The first section of the book presents a history of microelectronics and then discusses system concepts peculiar to integrated circuits. Following this, there is a brief description of fabrication processes for standard semiconductor elements leading up to planar and epitaxial technology as applied to integrated semiconductor circuits. There is also a good background to thin-film processes however this is only contained in one chapter out of the total fourteen, with some references in a section dealing with hybrid circuits.

The reader will undoubtedly find the chapter dealing with design considerations most intriguing, particularly with regard to such problems as layout, temperature effects, tolerance, and parasitics all of which are normally associated with conventional circuits.

All in all, this book should find its way to the bookshelves of most engineers and physicists in this country who wish to keep abreast of this rapidly developing technology.

"Solid Circuits and Microminiaturization" by G. W. A. Dummer and published by Pergamon Press, Oxford — 346 pp. — The material published in this book is a collection of papers and reports of discussions from the Conference on Microminiaturization held at the West Ham College of Technology in June, 1963. Delegates at this conference were representative of commercial firms, universities, and both industrial and government laboratories, throughout England.

It is most amazing to note that this conference was held some two years ago and that this copy for review only came to hand earlier this year. In fact, it would appear that publication was at least one and a half years after the conference. Surely the papers presented would have been of more use in a loose duplicated form. Looking back, the 'state of the art' in this field has been changing so rapidly that in a few years this book will be little more than an historical reference to the early days of microminiaturization.

As must be expected, there is a certain amount of repetitive theory, processes, and techniques in each paper and this tends to become somewhat tedious if the book is to be read from cover to cover. Conflicting ideas expressed in the individual papers and the ensuing discussion confuse the reader rather than instruct.

Little emphasis seems to have been given to thin-film and hybrid circuitry, rather, the papers are devoted more to integrated semiconductor devices. In view of the present day controversies regarding development of thin-film techniques for active devices, monolithic silicon passive circuits, and hybrid circuits it now seems that such a conference would have been better directed toward the even then realised future developments.

The book would be of little value to the average electronic engineer in New Zealand.

"American Miniature and Microminiature Electronic Assemblies Data Annual — 1963/64" — 359 pp., by G. W. A. Dummer and J. MacKenzie Robertson, and published by Pergamon Press, Oxford. It is pleasing to note that already an attempt has been made to produce a comprehensive Data Annual for miniature and microminiature equipment being produced by various manufacturers.

The book not only details specifications and circuitry for single 'micro' units, but also describes their applications, and complete assemblies such as amplifiers, filters, timers, oscillators, computers and other fully assembled equipment.

Normally, to obtain such information it would require spending considerable time requesting and collecting data from the manufacturers, as presently experienced with standard equipment. Although virtually no work is being carried out in the microelectronics field in this country, it most certainly will in the near future, so that this and/or subsequent annuals would prove immense assistance.

P.L.W.

ENQUIRY CARD AD. 18

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ENQUIRY CARD AD. 19

REDFERN POWER TOOL SPEED CONTROL

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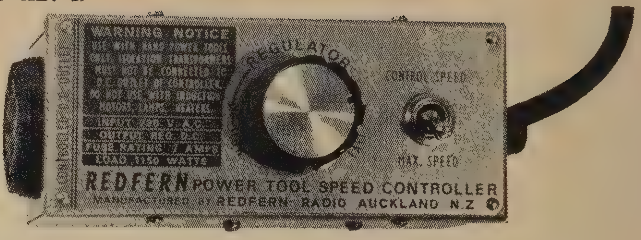
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The speed of the tool can be adjusted from crawling to maximum to suit the job in hand.

The Speed Contoller produces a D.C. regulated output from 230V AC mains and must therefore be restricted to use universal AC/DC or commutator type motors.

Specifications:

For use with 230V AC only. Maximum load restricted to power tools employing universal motors up to 5 Amp. nameplate current rating or 1250 Watts. Speed variation depends to some extent on motor characteristic, but normally ranges from crawling to normal speed with constant torque at all speeds. A bypass switch is fitted cutting off control when required. A 5-Amp. cartridge fuse is fitted. The controller may be used off an isolation transformer, but the isolating transformer must never be connected to the DC outlet of the unit.

Dimensions: 6½" x 2½" x 3⅛". Weight: 1¼ lb.

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ENQUIRY CARD AD. 20

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Mobile Communications — *Part VI*

by Countryman

Allied to the true mobile field is that of portable radio. In fact at least one N.Z. manufacturer produces a VHF Mobile set which may be taken out of the vehicle and used with rechargeable batteries in a semi-portable role, but as far as true portables are concerned I do not know of anything available "off the shelf".

I can recall references well before the World War II in overseas magazines to portable sets "just ready for production", but to the best of my knowledge none of these sets went much further than the drawing board. With our advantage of hindsight we can see that these sets were doomed before they started without transistors, or even miniature valves as we know them today.

In N.Z. there has always been a more or less unsatisfied demand for some form of portable radio for people in back country areas, such as hunters, surveyors, musterers and so on, but this has had to be filled where possible with the ubiquitous ZC1, and one requires a vivid imagination (or to be a signals NCO), to call that portable.

Because there was nothing available either here or overseas, the Forest Service, in 1958 signed a contract with a N.Z. development company to design a portable set, and some four years later about three hundred of these went into use. So far as I am aware this set is the only one which has seen any quantity production, and although there seems to be a fairly steady demand for HF portables, no manufacturer seemed anxious to tap this field, at least while TV continued to offer quick returns.

A portable set for N.Z. conditions would of course be in the high frequency band, be crystal controlled and would need to have an output of about one watt and be operated from batteries, but after that sets could vary as the designer wanted — including type of aerial and number of controls. It appears to be a common failing amongst designers, or those who write specifications to forget that sets may have to be used by unskilled people and that for this reason the number of controls should be kept to a minimum. A radio set should be no more difficult to operate than a telephone, or at least that is a desirable objective. What are the minimum requirements for controls? Obviously an on/off volume control, and a push to talk switch.

Once you go beyond this then you are getting into the class of set that requires some operator training, and when you have rows of knobs for aerial loading, tuning, squelch, etc., then you are getting into the technician class so far as correct operation is concerned. This is all right if you can get a technician operator, or if you are like the armed services and can spend plenty of time training operators. The trouble is it usually turns out that when the set is needed it's the trained operator who is injured and for whom the help is needed, or you cannot get hold of your trained operators and must use the first three volunteers who come along. In these cases the radio must be of the "set up and go" type.

Of course there is no set that cannot be misused in some way, as I have found out through bitter experience, but with few controls there is less likelihood of complete operating failure. An operator is much more likely to be happy using a simple set; lack of confidence on the part of the operator will be fatal to good procedure.

In line with simple controls must be a simple aerial system, and in this respect it is impossible to beat a centre fed halfwave aerial made out of "trurip" or similar wire. A half wave aerial will always present a resistive load to the transmitter, and can be pretuned in the workshop before use. There is no need for any tuning control on the set, and no messing about with earth spikes or counterpoises. Using a half wave aerial, ranges of the order of 10 miles are easily reached in the 4-5 mc/s region during daylight hours.

At various times I have heard claims made for whip aerials which would appear to make them as good as the half wave, but in my experience none of these claims will stand up consistently. It is one thing to get good ranges from a whip from a building or paddock within a few tens of yards of power wires or telephone lines, but take the set out into the country well away from stray conductors and the ranges will be drastically reduced. Aerials are a bit like boxers, a good big'un will beat a good little'un any day. I know of one place in N.Z. where I can work a base station 30 miles away on a four ft. whip, but it's a fluke and I cannot work the station again until I am within about one mile of it!

Insofar as power supply is concerned the choice is wide. Dry batteries, rechargeable cells, lightweight, heavy duty — take your choice. One thing is certain, if you intend to use the set away from HQ for long periods then it should be able to use standard batteries that you can get from any backcountry general store (now more generally known as a rural supermarket). It's a bit silly to have a set that will not go because it uses an XYZ123 cell only obtainable (at great expense) from the N.Z. agent who has just used up all his import licence!

TEN-TRANS
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As from December 1st, 1965, all manufacture and distribution of TEN-TRANS products — converters, etc. — is being handled by—

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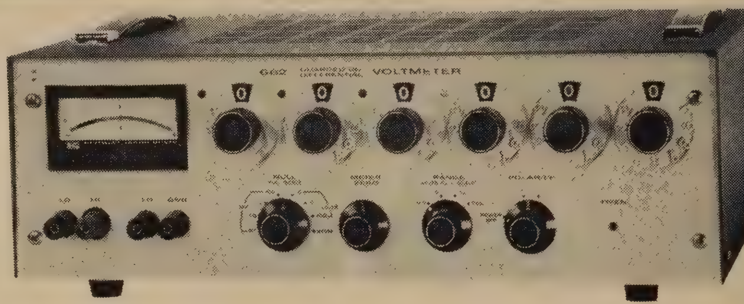
ENQUIRY CARD AD. 22

focus on our agencies

New differential voltmeter features 0.01% limit of error with 0.005% stability



The newest differential voltmeter from Keithley Instruments. Model 662 is a self-contained guarded potentiometer. It economically and conveniently measures dc voltages from 100 millivolts to 500 volts with a limit of error of ± 0.01% and has stability approaching that of a primary standard. The 662 has infinite input impedance at null over its entire range. Also six dials assure that every voltage setting has at least 5 dial resolution.

Additional features include a polarity reversing switch a recorder output and ability to float up to 500 volts off chassis ground. The 662 operates from 117 or 234 volt. 50-60 hz power sources. It is supplied as a bench model and can be converted to rack mounting with an accessory kit.

APPLICATIONS

The 662 meets exacting requirements in research, development and production for accurate voltage measurements. It can be used with a recorder to detect source instabilities down to 25 ppm over weeks of continuous measurements. Typical applications include calibrating power supplies and meters monitoring noise transients and drift in precise voltage sources, such as Zene diodes and electro chemical cells. When used with the Model 6601A Divider the 662 can measure up to 5000 volts within 0.02%.

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— VIEW —

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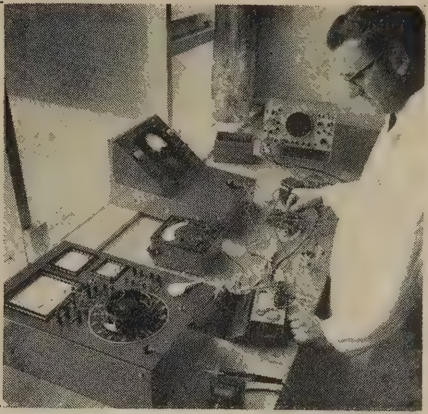
Mr. C. L. Herbert
Design Engineer:
Mr. G. Moyle, B.E.



To many, ATC is known mainly as a supplier of isolating or step down transformers. Whilst we were aware of their production of power and audio transformers, it came as a pleasant surprise to find stock lines in much wider diversity than one would imagine from their modest advertisements and sales material.

With a staff of over fifty, this company, started about fifteen years ago as a two-man effort, has made rapid but stable progress in a field of moderate specialisation without losing sight of the need to cope with both stock lines and "specials" or "one-offs." In fact, the "special" transformer has always been one of ATC's strong points and reasonably quick delivery has always been aimed at in this department.

At present the stock lines number almost four hundred, with very few gaps on the shelves at the time of our visit and against this, so far this year, about four thousand "special" job cards have been written — some for one only, some for fifty or more.

Parallel with the facility for both stock and specials production, the company has recently developed several new lines that are, in a way, a departure from former production interests. These include — constant voltage transformers, constant potential battery charges for industrial and similar use, regulated D.C. supplies using transistor circuitry, and demagnetisers. Also, just recently ATC acquired Ten Trans and, under a manufacturing and marketing agreement, will be manufacturing this line from the beginning of December.

The greater interest in newer lines and determination not to let stock production swamp the specials has meant that plant increases have been made and the latest acquisition is an AVO programmed multi winder, capable of winding 12 units simultaneously. Next year should also see further increases in winding plant.

Production of television transformers and components has only been a part of Auckland Transformer Company's total output, and the TV sales decline should not affect them much.

In fact, their output is directed at widely varied markets — the building industry, motor industry, N.Z. Railways, Post Office, Ministry of Works, Hospitals and all aspects of the radio industry. The production capacity of ATC is well able to cope with sudden large increases in output. This is exemplified by their achievement in keeping Pye fully operational after their disastrous fire in Paeroa. ATC, with their established design office, have a strong position and they are conscious that as demand increases they must further expand their design staff and instrumentation to meet the need for design hours and specification testing.

Mr. Herbert and ATC have a sound background of stock lines and production — and premises with adequate space for expansion. Our hope is that the manpower and equipment needed for specials and "new line" development will not be drawn off into the more profitable stock runs, as is so often the case in other sections of the industry. Certainly, to date this has not been the case, as some eight hundred thousand specials alone in fifteen years will testify.

ENQUIRY CARD AD. 23

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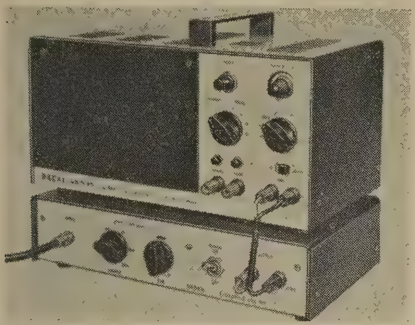

DECADE DIVIDER UNIT

A new decade divider unit, type SA 548, has been introduced by Racal to extend the frequency coverage of their 1.2 Mc/s counter/timer to a minimum of 15 Mc/s and give direct frequency display without the need for interpolation or tuning. The unit can also be used to extend the frequency coverage of any 1 Mc/s counter to a minimum of 10 Mc/s. Although input signals may be as low as 100mV, facilities have been incorporated to enable the user to discriminate against unwanted low level signals by controlling the level of input signals accepted, in six ranges up to 300 volts.

The SA 548, which operates from any standard mains supply, has been designed to form a plinth upon which the Racal type SA 535 1.2 Mc/s counter/timer stands.

The SA 535 is a fully portable transistorised digital counter/timer weighing only 9 lbs (4, 1 Kg), designed for direct frequency measurement up to 1.2 Mc/s and time measurements up to 10^4 seconds in steps of one microsecond, with an accuracy of ±1 count ± internal crystal frequency stability. In addition, period measurement facilities are incorporated to enable low frequency signals to be measured with very high accuracy. Readings are displayed on a new type of six-digit readout which enables the measured quantity to be easily read over a wide viewing angle in high ambient light conditions. The unit operates either from a standard mains supply or from external batteries.

ENQUIRY 239

* * *

INDUSTRIAL LAMINATES AID DESIGNERS

As with all modern devices incorporating a cathode ray tube, television receivers continue to make advances in appearance, performance range and method of operation. An English firm which decided to use an industrial plastic laminate Grade DCC 20 for the printed circuits in their latest large screen received awards for the excellence of their design.

DCC 20 is a copper clad laminate used in all sections of the electronics industries. It is manufactured from a number of sheets of kraft paper impregnated with phenolic resins and bonded, together with electrolytically pure copper foil, under controlled heat and pressure, to form a rigid, dimensionally stable board. The copper cladding can be on one or both sides in thicknesses of 0.0015 ins. or 0.003 ins. It has good electrical and punching properties and is exceptionally resistant to "tracking" — the formation of a carbonised conducting path across the surface of the bare laminate after the copper has been etched away. It is also suitable for high voltage applications, with an insulation resistance of 2×10^5 megohms when measured by standard test, while a low power factor of 0.045 at 1 Mc/s commends it for high-frequency work.

ENQUIRY 230

* * *

RADIOS FOR SHERPA HOSPITAL

The world's most remote hospital, 13,000ft up the slopes of Everest, will have two powerful radio-telephones to provide a "lifeline" with civilization. Mr G. A. Wooller, managing-director of Pye Limited, has presented the two sets, valued at more than £600, to Sir Edmund Hillary, chairman of the Sherpa Hospital Appeal Committee, who will lead an expedition into Nepal next year to begin construction of a six-bed hospital for 4,000 Sherpas in the Khumbu area of the Himalayas.

The two transmitter-receivers presented to Sir Edmund will give hospital

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staff a vital link with Kathmandu, 160 miles away. By foot it would take at least eight days to reach Kathmandu with a message, and a further eight days to return. Another vital link for the hospital, which will be built at Khunde, near the Tibetan border, is the airstrip which Sir Edmund and his party built last year. The radio-telephones will make it possible for the N.Z. hospital staff to give pilots advance information on weather conditions in the valley.

Radio interference will be no problem, despite the remote location of the proposed hospital. Mr Peter Mulgrew, who is treasurer of the Sherpa Hospital Appeal Committee and New Zealand manager of Pye's Telecommunications Division, says the sets are powerful enough to receive a clear signal from almost anywhere in the world, and the design is such that interference is virtually eliminated. The sets are simple to operate, without expert radio knowledge.

ENQUIRY 247

* * *

N.Z.B.C. TELEVISION EQUIPMENT

N.Z.B.C. has placed an order in Britain for the supply of fixed microwave link and associated tower equipment worth approximately £40,000. Carrying both vision and sound signals, the equipment will be installed in the Wellington and Christchurch regions. The links will operate between 7000 and 7300 Mc/s.

Automatic gain control switching and sub-carrier protection units were designed to meet N.Z.B.C. requirements for automatic changeover in the event of signal failure anywhere on the multi-hop link path.

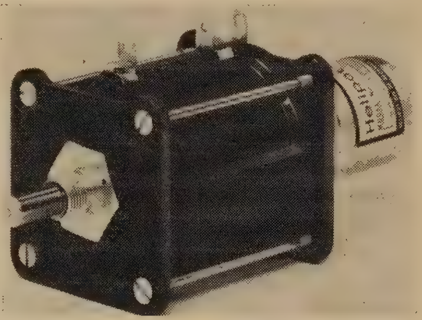
Fixed microwave link equipment of this type provides high quality point-to-point video links on 405, 525 or 625 lines standard. It can be supplied to operate in the 6875-7125 Mc/s, 7050-7300 Mc/s, 7300-7550 Mc/s or 7500-7800 Mc/s band. A high-power reflex klystron with a nominal power output of 2.5 watts is used. Its frequency can readily be adjusted to any value in its specified band.

ENQUIRY 245

* * *

LOW COST MOTOR-POT

Helipot Model 943 Motor-Pot is a Series A ten-turn potentiometer coupled with a small dc gearhead and slip clutch.



Potentiometer resistance values are from 10 to 648 and 100 ohms are available with linearity tolerances as low as 0.05%. Two 1 13/16 inch diameter Series A pots may be ganged, providing an additional pot output without exceeding the driving limits of the motor.

Ten gear ratios and two motor models afford the selection of components to satisfy most pot drive requirements. Nominal input voltage is 4.5 dc; however, by varying the input, the motor speed may be changed slightly.

ENQUIRY 222

* * *

TACHO-RATIOMETERS

Details of a new and extensive range of digital tachometers and tachometer ratiometers introducing a large clear numerical display as an alternative to Dekatron display, have been announced by Advance Controls. Sixteen standard models are available for early delivery, the variations in specification including either four or five decades and the use of either an internal crystal oscillator or the supply frequency as a time reference.

A wide range of applications include the accurate measurement of frequency, shaft or machine speed or the ratio between two speeds to three places of decimals. This ratiometer technique enables percentage stretch or percentage draw measurements, to 0.1%, to be made in textile, plastic, paper, metal or other continuous process industries.

Input signals are usually obtained from Advance magnetic transducers but other devices can be used, including tacho-generators, proximity detectors or photo-electric devices.

ENQUIRY 227

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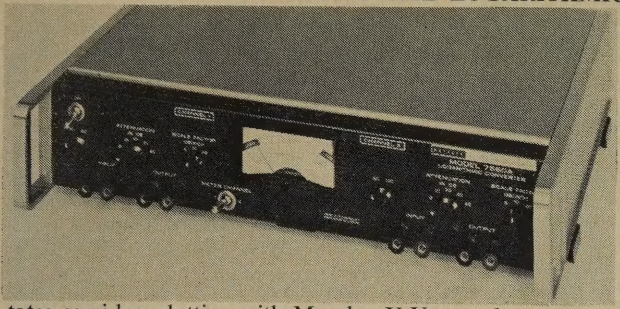
COMPACT TWO-CHANNEL LOGARITHMIC CONVERTER



A new solid-state instrument from the Moseley Division, Hewlett-Packard, accurately delivers logarithmic counterparts of dc or ac signals to 100k hertz. Two entirely separated channels of improved performance are provided in the space formerly occupied by one. Model 7560A facilitates semi-log plotting with Moseley X-Y recorders, acts as the logarithmic converter in decibel systems, or serves as a computing element to multiply and divide. Each channel has 60 db dynamic range.

In ac application, the Model 7560A user may select either peak or average detection. Accuracy is 0.5 db to 50kc, 1.0 db to 100k hertz. Input attenuators provide full-scale input ranges from 1 mv to 100 v ac, 3.16 mv to 316 v dc.

ENQUIRY 235

* * *

BREAKTHROUGH IN MICROWAVE RADIO EQUIPMENT

A new range of completely semi-conductored microwave radio equipment is now being produced in Britain.

A company has successfully produced equipment using semi-conductors exclusively; this means that all the advantages offered by semi-conductors are fully exploited.

One piece of equipment is suitable for main trunk routes and will carry 960 speech circuits, or a television channel plus associated sound, in the frequency bands 1700 - 1900 Mc/s and 1900 - 2300 Mc/s. The transmitter power output is two watts and the receiver incorporates a low noise input stage, employing a tunnel diode amplifier, having a noise factor of 5½dB. The broadband equipment is associated with a completely semi-conductored auxiliary radio channel and multi-RF channel protection switching equipment.

The second equipment operates in the frequency band 7425 - 7725 Mc/s and, having a capacity of 300 speech channels, is particularly suitable for providing high reliability circuits for the smaller telephone Administrations, and for spurs from high-capacity broadband routes. A twin path bothway repeater is packaged on one rack complete with switching, order wire and remote alarm equipment. A useful feature in this equipment enables any portion of the baseband to be dropped and reinserted at any repeater station without demodulation of through circuits.

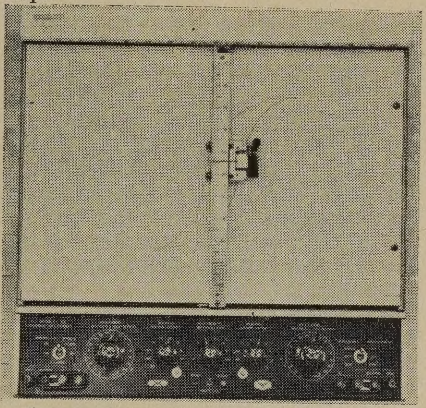
ENQUIRY 180

* * *

HIGH SENSITIVITY DC X-Y RECORDER

A new 11 in. x 17 in. X-Y recorder has 17 calibrated D.C. ranges on each axis, with sensitivities from 100 microvolts per inch to 20 volts per inch and 140 db common mode interference rejection on the three most sensitive ranges, advantages not previously available in a single instrument of this type.

From the Moseley Division, Hewlett-Packard, new features in Model 7001A include an improved time base with 8 calibrated sweeps which are applicable to either axis, a continuously adjustable sweep mode with automatic recycling, a push-button "zero-check" switch in each axis for use in aligning the pen during recording, and a wide range zero offset providing a maximum of four full scale-lengths of suppression in conveniently calibrated 5-inch steps which are also continuously adjustable between steps.



Standard equipment with Model 7001A includes one megohm input resistance on all ranges, the exclusive Autogrip platen which electrically grips any size paper, and maintenance-free multicontact flat mandrel balance potentiometers. Provisions are built-in for the addition of all the HP/Moseley analog, digital, and roll-chart accessories.

ENQUIRY 223

* * *

TRANSISTORISED EQUIPMENT SERVICING

Dealers and others experiencing problems with transistorised equipment are now offered the services of a company specialising in repairs to everything transistorised. The company is an authorised service agent for Sanyo, National, Auto Ten and Autocrat. All foreign sets can be serviced, but the company does not supply spare parts.

Transistor television work is undertaken. Company facilities allow specialised attention to channel changes and tune-ups. All types of radio telephone servicing and installation — including citizen band and marine R/T are provided. Domestic radio and appliance servicing are done and all repair jobs are returned within seven days.

ENQUIRY 246

MAJOR X-RAY INSTALLATION

Equipment suitable for the most advanced diagnostic x-ray techniques was recently commissed at the Christchurch Public Hospital. It was supplied by Amalgamated Wireless (Australasia) N.Z. Limited and installed by the company's x-ray engineers.

The equipment comprises a motorised tilting table with moving table top and fully automatic serial changer. A special feature of the installation is a high-power x-ray generator rated at 150 KV 1000 ma. This unit employs electronic switching at the secondary side of the HT system which enables ultra short exposure times, permitting up to 100 pictures to be taken per second. An Elema-Schonander rapid film changing device, with a programme selector was also supplied by A.W.A. thus providing all the facilities required for Angiography and other specialised radiological examinations.

ENQUIRY 244

* * *

DIFFERENTIAL PRESSURE TRANSMITTER

A new electronic differential pressure transmitter is available overseas. It converts differential pressures from 20 to 1000 inches of water into a proportional 4- to 20-milliampere d-c output signal.

The transmitter (model 150) can be used to measure differential pressure, rate of flow, liquid level, specific gravity, and other variables in a variety of industrial processes. It is especially applicable where high accuracy, corrosion resistance and low maintenance are required. Its output can actuate electronic indicators, recorders, and automatic controllers, or provide an input to analog and digital computers.

The transmitter is compact, easy to handle, and can be installed in any position. By selection of proper diaphragms, it can be used with corrosive fluids and for working pressures up to 1500 psi with full over-range protection. Two-wire transmission system simplifies wiring connections. External zero and damping adjustments can be made without removing cover or turning off the transmitter. Accuracy is ±0.5 percent of span.

ENQUIRY 236

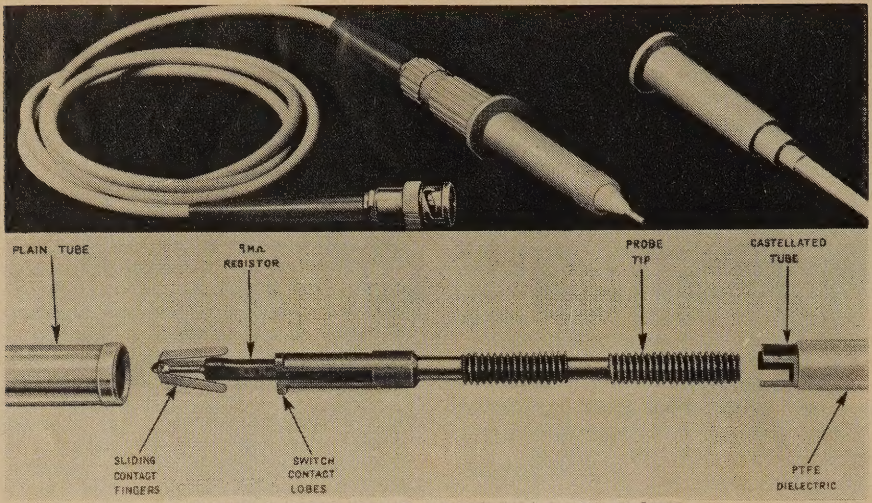
* * *

ADVANCE IN THE PACIFIC

Advance Electronics Limited have concluded agreements with Jacoby Mitchell Holdings Limited, electronic engineers of Sydney, Australia, by which the latter are appointed sole distributors and manufacturing licensees for Advance products in Australia, New Zealand and South-East Asia.

The agreements also provide for technical co-operation between the two companies and for licensing by Advance of certain products developed by Jacoby Mitchell. To implement these Agreements and to increase their productive capacity, Jacoby Mitchell Holdings Limited have announced that they are building a new factory in Sydney.

Further news concerning increased activity in New Zealand is expected shortly.



HIGH IMPEDANCE ATTENUATOR PROBE

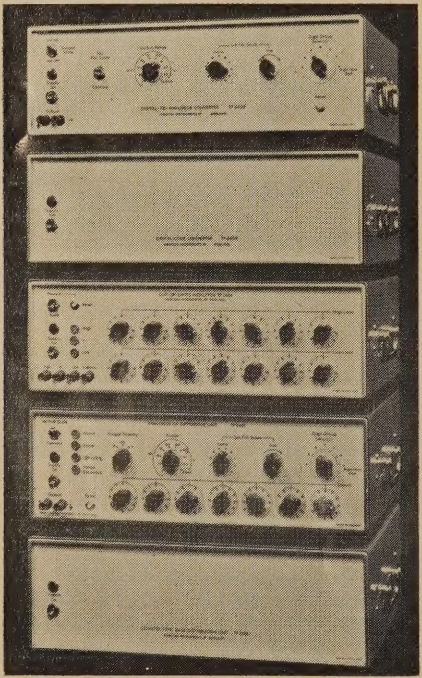
The only pobe of its type available, the Marconi TM 8110 presents an impedance of 10 MΩ in parallel with 9 pF when in the X10 position; its special low capacitance connecting lead is light, flexible and robust, the material used for the outer cover resistant even to accidental contact with soldering irons. When greater sensitivity is required the probe is switched to its x1 position, where it functions as a straight through low capacitance probe.

ENQUIRY 248

* * *

NEW ACCESSORY UNITS FOR COUNTERS

A new range of accessory units has been designed by Marconi to extend the applications for their transistorised counters used for recording and control. The range comprises a digital-to-analogue converter, digital code converter, out-of-limits indicator, analogue-of-difference unit and a counter time-base distribution unit.



The digital-to-analogue converter type TF 2402 produces a voltage or current analogue of any three consecutive digits or the last two of the counter reading to drive pen recorders which provide an automatic plot of the change during a series of readings. Internal attenuators are provided which give a wide range of outputs up to 5V or 2.5 mA. In this way most pen recorders can be operated without modification.

The numerous digital printers available have many different requirements and the various versions of the TF 2403 Digital Code Converter convert the 1-2-4-8 BCD used in Marconi counters to alternative codes.

The TF 2404 out-of-limits indicator monitors counter readings and indicates where they are too high, too low, or between two pre-set limits. The indication takes the form of a visual signal, plus either a relay contact closure or an electrical pulse.

The TF 2405 Analogue-of-Difference Unit provides an analogue of the difference, positive or negative, between counter readings and a manually set datum. Wide ranges of output are available up to 2.5 V or 2.5 mA. Direct plotting with a pen recorder of the error of readings can be effected, and the instrument may also be used in some proportional control applications.

The TF 2406 Time-Base Distribution Unit is designed for use in a system which requires counter facilities at several positions. It amplifies the time-base from a master counter and distributes it at 75 ohms impedance to as many as eight slave counters, which are considerably cheaper than standard counters. The system requires no other inter-connection and there is no time-sharing between the various positions.

ENQUIRY 240

* * *

DISTORTION FACTOR METER

The latest addition to the Dymar system of plug-in instruments is the type 765 distortion meter. This instrument permits the measurement of the total harmonic distortion of an audio frequency in the range 20 c/s-20 Kc/s.

The principle employed is that of rejecting the fundamental component of the applied wave and measuring the residue. The voltmeter ranges are calibrated directly in % distortion and measurement capability extends from 100% down to 0.025%. Measurements can also be expressed in db below fundamental. An L.F. cut is provided to eleminate "mains hum" components.

Frequency Range: 20 c/s - 20 Kc/s in 6 bands.
Sensitivity: 300 mV - 10 V.
Input Impedance: 100 K Ohms.
Distortion Factor Range: 100% - 0.1% f.s.d.
Rejection Filter:
  better than 70 db (Fundamental)
  not more than 0.5 db (2nd harmonic)
Inherent Noise:
  not more than 0.01% 200c/s-20Kc/s
  not more than 0.04% 20c/s-200c/s
L.F. Cut: 3 db at 400 c/s
  20db at 50 c/s.

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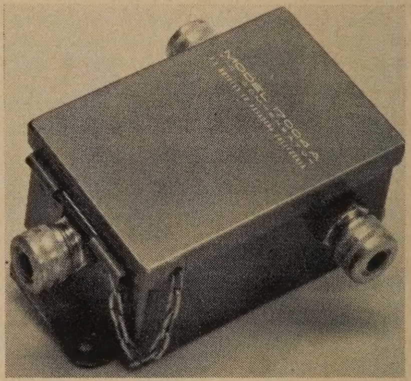
COMPENSATOR FOR COLD JUNCTION THERMOCOUPLE

A compensating device for cancelling the error introduced by changes in ambient temperature surrounding a thermocouple which is calibrated to a specific reference temperature is announced by the Moseley Division of Hewlett-Packard.



The Model 17004A Remote Reference Junction is a moisture-proofed module which can be located near the thermocouple operating location to maintain thermocouple emf output within ±0.5 of a degree in relation to the specific reference temperature over an ambient range of 0° to 55° C.

Leakage resistance of the module from input to output is greater than 1000 megohms. The compensator connects between the thermocouple and a Moseley recorder. It consists of an independently powered standard bridge circuit using a temperature sensitive nickel resistor as the compensating element. Calibration and response characteristics are adjustable corresponding to tables of the National Bureau of Standards for various commonly used cold junction thermocouples. Five basic types currently available are calibrated for chromel/alumel, copper/constantan, iron/constantan, platinum-13% rhodium/platinum, or platinum-10% rhodium/platinum. The input of the device connects directly to the thermocouple, the output to a Moseley recorder.

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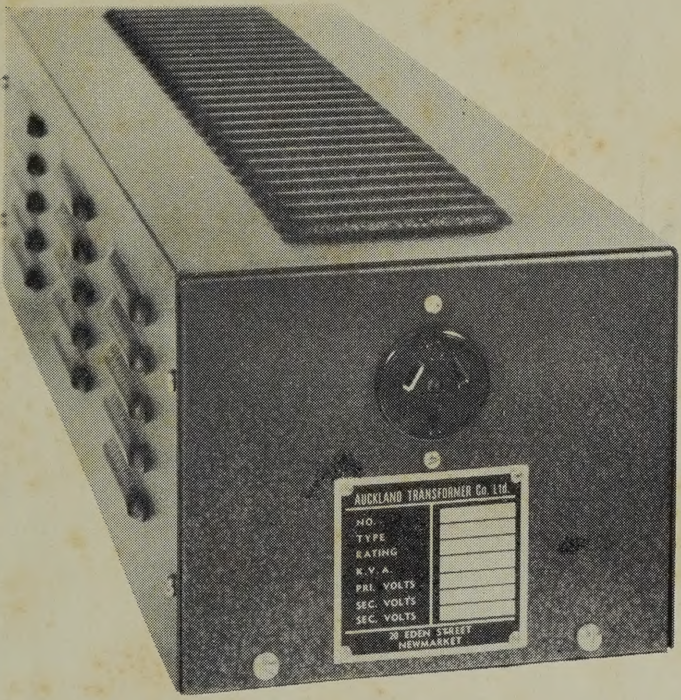

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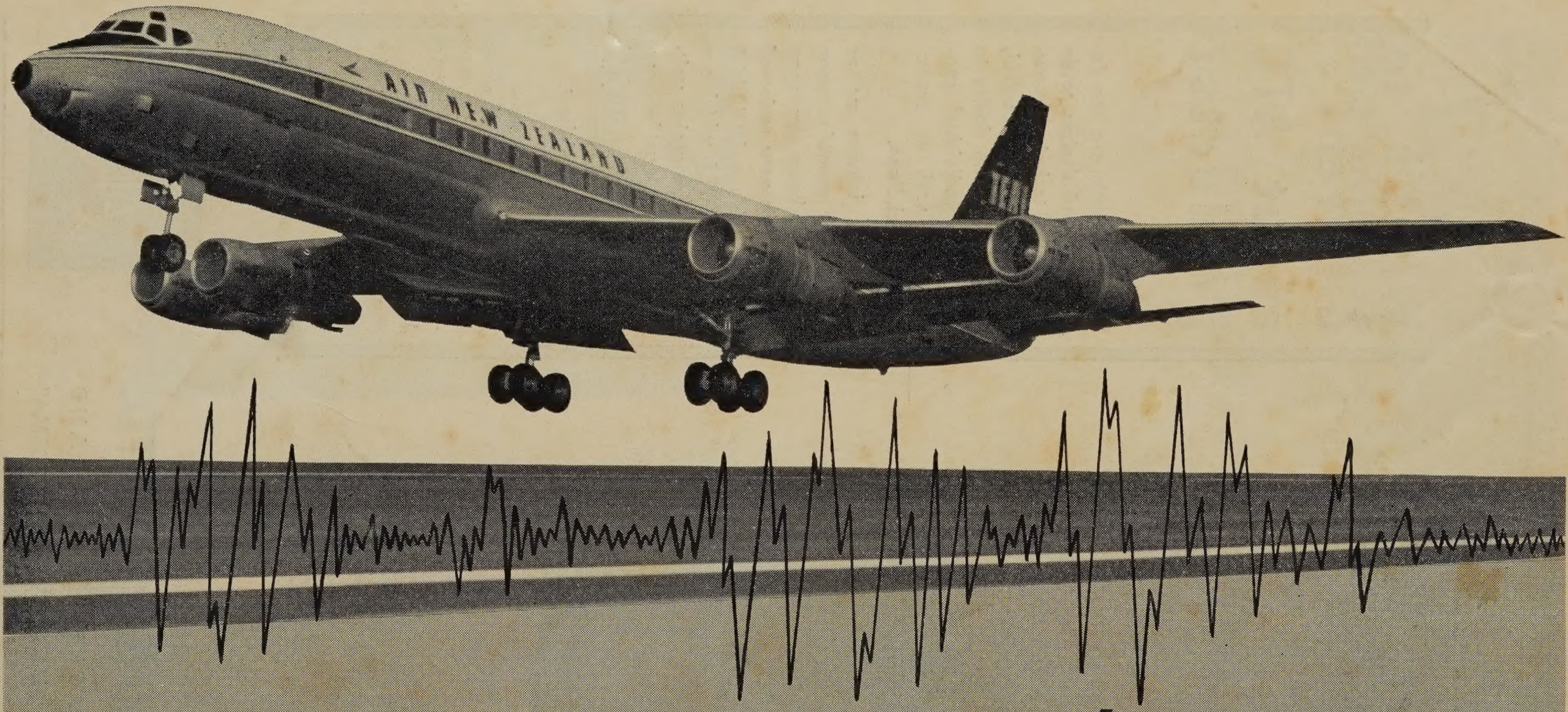

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